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ABSTRACT

The Phase I report explores alternative design approaches to the evolution of an integrated information system for the National Agricultural Library (NAL). During Phase I the study team reviewed on-going NAL operations, prepared flow charts of existing processes, analyzed files, forms and workload statistics, examined the Library's collections, measured performance, and discussed existing and proposed information services with a small subset of prospective users. The study revealed that NAL is effectively serving the Library user in spite of its current limited budgetary and manpower resources. There is a definite and clear need for a long range plan of improvement for the Library to enable it to keep pace with mounting departmental and national demands for increased access to agricultural information. (Author)

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1. 9010-004

Final Report

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PHASE I OF THE SYSTEMS ANALYSIS AND DESIGN STUDY FOR THE NATIONAL AGRICULTURAL LIBRARY

Submitted to:

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~~U.S.~~ Department of Agriculture
Office of Management Services
Washington, D.C. 20250

By:

Booz, Allen Applied Research, Inc.
4733 Bethesda Avenue
Bethesda, Maryland 20014 LYR06500

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BOOZ · ALLEN APPLIED RESEARCH Inc.

WASHINGTON CLEVELAND
CHICAGO LOS ANGELES

4733 BETHESDA AVENUE
BETHESDA, MD. 20014
656-2200
AREA CODE 301

August 15, 1967

U. S. Department of Agriculture
Office of Management Services
Washington, D.C. 20250

Attention: Mr. D. F. Peters
Chief, Division of Administrative Services

Subject: Final Report on Phase I of the Systems Analysis and Design Study for the National Agricultural Library -- Contract No. 12-03-01-5-20

Gentlemen:

Enclosed are twenty-five copies of the subject report. This report contains the results of the Systems Analysis portion (Phase I) of the Booz, Allen contract to design an Integrated Information System for NAL.

This report does not include discussions of the Phase II activities since we feel that this subject is not germane to the evaluation of the alternative approaches. However, we have been requested to comment on the NAL manpower efforts which might be required during Phase II.

At the outset of Phase II we will develop the detailed plan of work for the Phase II activities. Using the BAARINC proposal submitted on January 3, 1967 as a guide, we will establish the specific objectives, the areas of interest, and the schedule of events. In addition, we will identify the manpower efforts of NAL personnel which can be provided at the discretion of the NAL management. The close association of NAL personnel with the system design efforts has two major benefits. First, it assures that the specified system is kept within the context of the NAL. Second and equally important, it establishes an environment for the NAL personnel to become familiar with the system techniques and requirements before the implementation phase begins.

At the direction of the Contracting Officer we will initiate the activities of Phase II to provide a detailed design of the systems approach which is selected by NAL.

Should you have any questions pertaining to this report we will be happy to answer them at your convenience.

Sincerely,

W. J. Ulrick

BOOZ · ALLEN APPLIED RESEARCH Inc.

W. J. Ulrick
Research Director

Approved:

C. F. Riley

C. Frank Riley, Jr.
Vice President

dcs

Enclosures

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I. SUMMARY

I. SUMMARY

This Phase I report considers one aspect of the broad, two-phase task assigned to Booz, Allen Applied Research, Inc.; namely, to explore alternative design approaches to the evolution of an integrated information system for the National Agricultural Library.

During Phase I the study team reviewed on-going NAL operations, prepared flow charts of existing processes, analyzed files, forms, and workload statistics, examined the Library's collections, measured performance, and discussed existing and proposed information services with a small subset of prospective users. In accordance with the terms of the contract, no full scale user survey was undertaken.

The study revealed that NAL is effectively serving the Library user in spite of its current limited budgetary and manpower resources. It also revealed a definite and clear need for a long range plan of improvement for the Library in order to enable it to keep pace with mounting departmental and national demands for increased access to agricultural information.

These increasing demands upon the services of NAL have resulted in a need for:

- Improvement in responsiveness to the researcher's information demands
- The introduction of new bibliographical services
- Added capability to move from current library concepts to information services concepts
- The capability to realize the economic and technical advantages of capitalizing on other automation activities in the Government and private libraries
- An ability to contribute more effectively to national information programs.

While the proposed improvements in organization and management could undoubtedly improve the situation, they do not represent a long range solution to the problem, particularly in view of the constraining manpower environment. The application of Automatic Data Processing techniques could provide the necessary assistance by:

- Provision of a common machine base of agricultural information from which new information and supporting bibliographical services can be derived
- Creation of a mechanism for linking NAL's rich resources to the automated programs of the other national libraries and to the agricultural community at large

- Development of an operating system capable of absorbing increased NAL workloads and other USDA information projects such as CRIS, Pesticides, etc.
- Achievement of production goals and service response times available no other way.

Conferences with NAL management and staff indicate a general awareness that technological change is inevitable if the Library is to render the multiplicity of services which are necessitated by its national role. Essentially, NAL management is of one mind that some form of automatic data processing is essential to its operations.

While automatic data processing techniques are no panacea, they do possess the potential capability of meeting many of the information processing requirements which face NAL. The range of ADP approaches presented in this report offers the Department of Agriculture an opportunity to plan an integrated long range program.

While the four alternatives outlined were designed to demonstrate the range of processing schemes applicable to NAL, they, in fact, demonstrated only that the basic choice is between a batch processing system and an on-line processing system. Although the purely batch processing system is a practical design alternative for mechanization of the current operations, the advantages of an on-line system lie with future Library operations and the national information programs.

Selecting an optimum design approach is further complicated by the lack of quantitative evidence clearly supporting the user's requirements for NAL services. However, based on the evaluation presented in Section IV a solution does appear to present itself in the form of a combination of batch and on-line processing. It is estimated that this approach would result in an increased base cost of $350,000 over a conventional batch processing system. The real significance of this method is the flexibility of the implementation plan which permits:

- A system evolution responsive to changing needs indicated by growth and operating experience
- A controlled, orderly transition from the present NAL system to the fully-implemented system by sequentially replacing current operations with more effective methods until such time as on-line systems become operational.

Thus, the rate of growth and expenditures would be a direct result of the services, functions, and projects which are determined valid for implementation at any one point in time. Such a system would have almost unlimited capability to expand and subsequently capitalize on and take advantage of the continually developing ADP field.

II. INTRODUCTION

II. INTRODUCTION

The National Agricultural Library is part of a national library system with the National Library of Medicine and the Library of Congress. The responsibilities of these three national libraries include leadership in the acquisition, control, and dissemination of published information. However, this published information is of such a quantity and the need is so great for the ability to rapidly disseminate this information that automation is inevitable. The National Library of Medicine was the pioneer in the area of automation with its MEDLARS Program. A review of this system is presented in Appendix A of this report. The Library of Congress followed with Project MARC and a Systems Analysis Study. Now the National Agricultural Library is initiating its program of automation with the development of a machine-readable thesaurus and the award of a contract to Booz, Allen Applied Research, Inc., for a complete systems analysis and design study.

The primary objective of this Booz, Allen project is to provide the National Agricultural Library with specifications and plans for an automated library system.

The contract is divided into two distinct phases. Phase I requires that the project team study and analyze the present functions and scope of the NAL. Using this data, plus identifiable future services as a data base, alternative mechanized system approaches are developed and compared for fulfillment of the design criteria.

Phase II of the contract calls for detailed description of the selected alternative and planning for the organization, procedures, and implementation to support the mechanized system.

In order to meet the goal of Phase I it was necessary to establish secondary objectives around which the study tasks were developed. These task objectives were:

- Description of present NAL functions
- Description of present NAL services
- Identification and description of present NAL files
- Development of system design and performance criteria
- Identification and description of desired NAL services
- Development of mechanized file structures and contents
- Identification and description of alternative mechanized systems meeting the developed objectives and criteria.

In order to fulfill these task objectives the Phase I activities were structured into the four tasks described in the following paragraphs.

Data Collection. Familiarization with the Library and gathering of information descriptive of the Library processes was accomplished in this task as outlined in Section III. An initial impression of the Library's operation and role was developed through a review of pertinent documentation. Meetings were then scheduled with the supervisory and operating personnel of the major divisions and sections. Interviews were also conducted with representatives of the major USDA agencies, selected agency field libraries, Pennsylvania State University, the Library of Congress, and the National Library of Medicine. Supplemental interviews were held with Library personnel to review the results of the original survey and to gather additional information on the file structures and contents. This activity resulted in descriptive and quantitative information concerning the present Library structure, operations, and services.

Data Analysis. In conjunction with the gathering of information was the effort to analyze and formulate this data into criteria relevant to the development of mechanization approaches. These criteria are discussed in detail in Section III. The present Library processes were defined by flow charts which illustrates the major operations required for completion of each function. File structures and contents pertinent to these functions were described along with the procedures and forms utilized in the processing of documents. Available and desired services were defined by both their output characteristics and their implications on the internal functions. Finally, a list of system design criteria was developed as requirements for an automated system.

Alternative Design Approaches Development. Using the design criteria developed, Section III describes alternative methods of fulfilling these requirements. Each major Library function was reviewed against various methods of mechanization. Flow charts of required functions were developed to demonstrate the different mechanization methods which could be utilized. File structures and contents were developed to capitalize on the mechanization capabilities and the Library functions were assessed. Emphasis was placed on achieving overall systems which would enable the Library operations to be more responsive to the researcher requirements. Functional hardware and software requirements were then developed to implement the alternative design approaches for fulfillment of the design requirements.

Systems Evaluation Development. Subsequent to the development of the systems approaches was this effort to analyze the alternatives on a comparative basis. The parameters of the comparative analysis presented in Section IV included fulfillment of objectives, costs of implementation, ability to implement, benefits to be achieved, organizational implications, and manpower requirements. Descriptive and quantitative comparisons were developed for those parameters where variations between alternatives occurred.

An NAL Project Advisory Panel was formed to assist the Booz, Allen study team in its efforts. The panel consisted of four members of the academic and professional world with experience in the field of library automation, and information storage and retrieval systems. The panel members were Dr. Ralph Shaw of Rutgers University, Dr. Donald Swanson of the University of Chicago, Dr. Merrill Flood of the University of Michigan, and Mr. Joseph Becker of EDUCOM. The panel reviewed the efforts of the study team and provided commentary on the state-of-the-art techniques and equipment utilized in library automation projects.

The results of these efforts are documented in this report which completes the activities of Phase I of the contract.

III. NAL AUTOMATION

III. NAL AUTOMATION

This section is designed to present in narrative and graphic form an analysis of the major findings of the Phase I effort. It discusses NAL's current operations and outlines the required design objectives which will overcome some of the major deficiencies found to exist. It further proposes a range of automated systems which can meet the design criteria and discusses the organizational implications and methods of possible operation within NAL functional areas.

It has been difficult to decide which techniques of automation would best serve NAL. In part, this is because the design mechanization could not proceed from any one estimate of the required potential and performance of NAL. The value of performance to NAL is dependent upon the underlying factors of quality, quantity, timeliness, and relevance for each system output. The ADP design criteria and services listed in Appendix B consists of our quantification of these factors for each of the NAL functions and as such constitutes in part the basic system design objective.

In our opinion, the present manual system does not meet these criteria, principally because of its slow and confined response and the resultant limited influence upon the actions of the user.

1. BACKGROUND

The development of the NAL mechanized design alternatives was based on the set of design criteria. These, in turn, were the primary output of the data gathering and analysis efforts conducted early in this first Phase.

The data collection phase involved the gathering of current samples of inputs and outputs of the present system. Flow charts were created as an aid for organizing this data into an overall system pattern. The collection of this data was made from the internal divisions of the NAL:

- Acquisition
- Cataloging and Records
- Lending
- References
- Field and Special Services

From the data collection phase two major summaries were developed. The first summary was an identification of unique data elements found in the NAL files. These data elements were tabulated and used as a key to identify the information content of the second summary -- a listing of the major NAL files. This chart was used as a guide in the sizing of the computer memory and file structure. It was also used to aid in analyzing the files to determine those which could and/or should be automated in order for the system to work most efficiently.

Appendix C lists the data elements of both the present and the proposed files. It also presents a listing of the major files now in use by name, size, information content, arrangement, description, and frequency. Various smaller desk files and correspondence files are not included because their small size and low frequency of use do not suggest an advantage in their automation. Possibly some of the data elements included in these files may be used, however, in the computer memory as a part of the Master File.

2. SYSTEMS CONSIDERATIONS

(1) Introduction

At the present time NAL provides user services supported by many systems and procedures with very little aid from computers or automated devices. Under this methodology some 20 to 25 different three-inch by five-inch card files have been created and are being maintained by various sections of the Library. Each of these files contains much of the same data. However, each file is indexed depending upon the purpose and method of access. The task of introducing automation is primarily that of developing a common computerized file available to all parts of the National Agricultural Library on a time-shared basis. This objective is a practical one, based upon the modern computer's fast processing time and large data storage capacity.

(2) Hardware

The ultimate solution to the NAL automation effort will be based upon third-generation computer hardware. Compared with second-generation equipment, this hardware represents these major advances in the state-of-the-art:

- Higher density, lower cost mass memory devices
- Time-shared, multi-accessed, on-line response via user terminal devices
- Lower computational costs per job.

1. Memory Devices

A major factor in optimizing any of the system approaches is determined by the allocation of the data base to the required memory devices, that is, high speed magnetic cores, medium speed mass memory rotating devices, and lower speed bulk storage magnetic strip devices. The result of this design optimization has a great impact on the performance (throughputs) and cost of the overall system, with a much wider cost/performance variance possible for third-generation systems as compared to second-generation systems.

Machine storage devices are available with a considerable range of capabilities. As might be expected, these devices tend to fall into groups characterized by access time so that within each group a fairly direct cost versus file size is exhibited. In fact, there are three distinct groups. Organization of the data and its access logic for exploiting the intrinsic characteristics of each group is the requisite for a system with a balance between economy and effectiveness. All system configurations use the three types of storage in essentially the same way:

- Slow access storage for the basic data
- More flexibly accessed storage for the redundant data used to find the basic data
- Fast access storage for transient storage of data during search and logical operations.

The first of these three, bulk storage, is a fairly recent development available from a limited number of sources but nonetheless both obtainable and necessary to a cost-effective system. The moderately accessible storage is again a rather recent development but available in a wide variety from a multiplicity of sources. The fast access storage is an integral part of any modern computer readily available in a continous range of sizes that completely bracket the possible system requirements.

Magnetic tape drives and punched card devices have been included in each of the design approaches for the primary purpose of providing the vital hardware link to existing second-generation library computer systems. The capability to accept various forms of machine-readable

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media also provides for processing information from projects such as the Current Research Information System (CRIS) and the Pesticides Information Center (PIC). Once policy is established it is a matter of determining the format and operational requirements for processing.

2. Main Frame Computer

The type of computer main frame used to develop and support the material presented in the system alternatives is based upon the follow major characteristics:

- 24-bit word length
- High speed core storage expandable to 128K of 24-bit words (512K characters)
- A minimum of 8 Input/Output channels
- 500,000 comparisons per second.

These characteristics should not be considered a part of the final design effort but merely as representative.

3. Computer to User Throughput

The basic parameter for evaluating the NAL computer system performance is throughput, that is, how fast the user can receive data from the automated files.

Contributing to this are the following:

- Latency time of the mass memory devices (disc pack or data cell)
- Transfer time from mass memory devices to computer main frame
- Main frame (computer) processing time
- Transfer time from main frame to user terminal or printout device
- User and data preparation procedures.

From a computer design viewpoint, the relationship between the allocation of the data base, file structure, and format within the mass memory devices to the number of available, independent I/O channels is very significant. A typical retrieval time from a mass memory device to the computer is roughly 150 milliseconds (ms.). Transferring these data to a user terminal is not time consuming (1.50 μs/character) if the readout device is a cathode ray tube (CRT); however, transferring these data to a user typewriter can be roughly thirty seconds in a typical printout.

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(3) Assumptions and Constraints

In order to assist the Library staff in making a judicious decision in selecting the type of computer system applicable for NAL, the following factors are presented:

- Software Development. This is a major task in developing the operational system. The significant part of the effort will take approximately three to five years to complete, depending upon the type of system chosen and the complexity of supporting procedures. It is expected that software development will comprise 40% of the total computer investment.
- Systems and Procedures. New systems and procedures must be created within NAL to exploit the benefits of an automated library system. This will require high-level policy decisions and retraining of a large segment of the present Library staff, and user population. The time to implement this fully is estimated to be two to three years.
- Programmer-Analysts. The development of the software required to operate the system will require a nucleus of five to eight highly skilled system analysts. Grade levels for these people must be such as to attract competent, creative professionals. An alternative, useful on a short term basis, would be to hire a systems management team to develop the software and the inhouse capability simultaneously.
- Thesaurus Development. The vocabulary is an open-ended vocabulary to which new terms and further subdivisions of existing terms may be added. This characteristic must be retained for efficient software development and for efficient use of file storage devices.

- Data Base Buildup. The minimum amount of data inserted in the computer files in order for NAL to provide useful outside service is a current three-year period. This indicates the necessity of a rather long term phase-in of the new system, with concurrent maintenance and use of the existing system. Superficially, this appears inefficient and undesirable, but the alternative is chaos. An orderly approach is to begin building up in the computer file the data base required for a single internal library function such as serial records. When this single function has become a smooth routine, related functions of a purely internal nature may be logically added. When most internal functions have been included, the data base will be essentially complete in scope but limited to the data processed since the initiation of the various subsystems. When a sufficient data base has accumulated, pseudo-external functions such as subject searches by librarians may be initiated. As confidence in the pseudo-external functions build up, user access to the system becomes practical. The important concept here is the accumulation of an adequate, accessible data base prior to user exposure.

- Overlapped Operation. During the initial stages of software development and retraining of Library personnel the computer system must be operated in parallel or on an overlapped basis with the present NAL method of providing services. It is estimated that this overlapped situation will last for three to five years.

- Library Proximity to Computer. Since the completion of operational software packages will be in the form of a small R&D program subject to severe growing pains, it is imperative that the programmer-analysts be given top priority in "debugging" software on the actual system hardware.

- Retrieval of Documents. The computerized system considered does not attempt to solve the problem of physically retrieving and circulating monographs or serials from the shelves. This capability requires policy discussions on such costly items as:
  - Stacks open or closed
  - Reproduction of documents prior to circulation
  - Microform facilities.
- File Conversion. No conversion of existing data to a computerized file.
- Foreign Language Entry. All foreign language indexing and cataloging entries will be transliterated.
- Redundancy of Files. All basic data will be redundantly stored on either magnetic data cell modules or magnetic disc packs.
- The hardware listed will have a capability of supporting a five-year projection of data with allocations for 50% additional growth.
- The overall systems configuration will be capable of adding memory devices to include a 20 to 25 year data base.

It has been assumed that the quality of the data retrieved in each of the alternative systems will be the same and that file content and structure will be generally the same.

1. File Structure and Size

The ideal file would be one in which the data are stored once and only once. This should offer the most in economy. However, attempts to implement a practical, working system on such a basis soon would run afoul of hardware limitations since each data block is used for a variety of tasks. In an attempt to retain the inherent advantages of unduplicated storage, the computerized file structure is based on a dual level storage concept. The entire data base is stored once in a chronologically compiled file. The sole entry to this file is by accession number. If the accession number is structured so that it bears a logical relation to the file address, a simple algorithm will permit rapid retrieval from a slow access storage device. Thus, the criteria of economy and accuracy will be realized.

Such a structure is sorely lacking in operational utility. This single defect can be overcome if a rapid means can be achieved for ascertaining the accession number of the required data block. The starting point for finding the accession number is in itself a part of the data base (i.e., title, author, etc.). Thus, a degree of data duplication becomes unavoidable. However, this subset of the data base is quantitatively small, and each item need appear only once in these accession number locator files. Since this subset will not represent more than 20% of the data base, a duplication factor of 1.2 is required in contrast to conventional library files in which a factor of 15 or more is common.

2. Basic Data File

This file contains the working information on all documents in the Library. These data blocks are arranged by accession number and are accessible via an algorithm which converts accession number to machine file address. For convenience these data may be divided into three separate groups:

- Monographs
- Serial titles
- Journal articles.

There are several ways in which these may be handled. The first and second may be numbered separately or in combination depending in part on whether a serial title is later bound into an annual "book" and thus disappears into a new accession number. The third group may be treated as separate blocks or they may become subsets of the serial titles data. See Table III-1 for estimated file sizes.

Table III-1
Basic Data Files

FILE	RECORDS	CHAR/RECORD	BITS/CHAR	BIT CAPACITY
MONOGRAPHS	250 K	1.0 K	6	$1.5\ (10)^9$
SERIAL TITLES	25 K	2.6 K	6	$0.4\ (10)^9$
JOURNAL ART.	500 K 500 K	2.6 K 750 K	6 6	$7.6\ (10)^9$ $2.2\ (10)^9$

The second group of files are essentially a working index and their purpose is to ascertain the accession number given certain selected input data. The most frequent entries to the data base are by:

- Title
- Author

- Publishing agency's report number (pseudo-title)
- Order number (used administratively)
- Call number (pseudo-title).

The traditional subject file which would be expected to appear in this group is actually handled in three distinct files in order to encompass the vocabulary in a definitive and economical way.

The first of these three is the complete thesaurus file. The complete NAL thesaurus of preferred and accepted terms is arranged alphabetically on disc files. For each preferred term there is a unique numeric code. For each accepted term the numeric code for the corresponding preferred term is listed. The second file is a tabulation under each numeric code of all accession numbers that have been indexed under that term. Thus, a user could enter with a descriptor term, either preferred or accepted, using the English alphabet, and the computer would find the corresponding numeric code, extract all

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the accession numbers indexed under that term, and if desired, pull out the data filed under those accession numbers.

Two potential problems can arise. A user can enter with a term not in the NAL thesaurus. The computer will in effect say "no savvy." The user could browse through a printed copy of the thesaurus, but a machine-stored high-low file would probably save time. This third file is a tabulation of the next higher terms, the next lower and the horizontally related terms for each preferred term in the thesaurus arranged by numeric code.

It is possible that an unmanageable quantity of accession numbers will appear under a single descriptor term. Then the system will advise the user of the size of its finding. If the user agrees that it is unmanageable, he may then initiate a logical search. This requires no additional files only a comparison operation within the computer. These working index files are tabulated in Table III-2.

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Table III-2
Working Index Files

FILE	RECORDS	CHAR/RECORD	BITS/CHAR	BIT CAPACITY
TITLE	1.3 $(10)^6$	200	6	1.6 $(10)^9$
AUTHOR	3.5 $(10)^6$	60	6	1.2 $(10)^9$
REPORT	250 K	15	6	2 $(10)^7$
ORDER	275 K	12	6	2 $(10)^7$
CALL	275 K	12	6	2 $(10)^7$
THESAURUS	200 K 200 K	36 12	6 4	5 $(10)^7$
HI-LO	40 K	120	4	2 $(10)^7$
DESCRIPTOR	40 K	500	4	8 $(10)^7$

The remaining estimated files are more or less administrative in nature. They include:

- SDI
- L/C
- MEDLARS
- Chem Abstracts
- Budgets
- Use Factors.

These are all working files in that they provide for accumulation of data which is ultimately transferred to the main data base or used for the extraction of information. These files are listed on Table III-3.

Table III-3
Working Files

FILE	RECORDS	CHAR/RECORD	BITS/CHAR	CAPACITY
SDI	1,000 2,000	280 30	4 6	$1\ (10)^6$
L/C	50 K	1 K	6	$3\ (10)^8$
CHEM. ABS.	25 K	1 K	6	$1.5\ (10)^8$
MEDLARS	25 K	1 K	6	$1.5\ (10)^8$

The total estimated storage for all files is planned to be 3×10^9 characters of which all but 50×10^6 characters will reside in magnetic strip bulk storage. This smaller portion will be contained in disc memories to allow rapid computer access to the data most frequently searched and requiring the most manipulation to service typical queries. Included in this is 6×10^6 characters allocated for program storage.

Having covered the data and working files, there is one remaining major requirement for machine storage. That is of the system operational or supervisory programs themselves. This software must be resident in random access core at all times and is planned for a maximum of 24K words. The working programs will be stored on discs and called into core as required by the supervisory software. To allow for the operation of several jobs, space must be allocated for a minimum of an additional 8K words of core storage.

3. ALTERNATIVES OF DESIGN

The alternate approaches are a selected representative set from a wide spectrum of possible solutions. The basic variations are derived from real time processing techniques as opposed to batch processing techniques.

(1) Batch Processing Technique

Batch processing of jobs is a common everyday practice in providing data processing services. Each of the system alternate approaches utilizes this principle to a varying degree. The term as applied to the NAL computer effort relates primarily to the practice of manually placing (by operators) on memory drive units only those modules (magnetic disc packs or magnetic strip cell sections) which are needed to perform one job or a series of very closely related jobs. This method of organizing computer operations allows for a reduction of memory hardware along with the use of the most simple type of operational and working software packages. The attractive features of hardware and software simplicity and low initial cost soon run afoul of the scheduling problem with its consequent lack of responsiveness and the rapid accumulation of secondary costs.

In addition, a true batch processing technique does not permit the user to query the data base directly from a remote terminal since a specialized data preparation step is required to produce a machine-readable query or data entry.

(2) Real-Time Processing Technique

On-line processing with many simultaneous users interrogating a common data base has become a practical reality with the advent of third-generation computer systems. Utilization of the real-time processing technique requires the use of more sophisticated hardware and software. Where real-time processing capabilities are discussed in the alternative system approaches section, the following factors have been applied:

- Dynamic Memory Allocation and Protect Hardware - The ability of the computer system to isolate different user jobs from each other to the maximum practical extent.
- User Terminals - User on-line entry and readouts are performed by any of three types of device; namely:
    - CRT/Keyboard - used for high speed data base interrogation and data entry (1,000 characters per display)
    - Typewriter - utilized for user-oriented hard copy printouts (large volume, multiple distribution printouts use the common high speed printer)

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  - Automatic Transaction Recorder - provides capability for adding data changes to an existing document record via the insertion of a machine-readable card or tape

- Supervisory Software - The basic cost, development, and responsibility for the real-time supervisory software is to be absorbed by the computer system manufacturer

- Computer-to-Computer Communication Link - A computer Input/Output (I/O) channel is reserved for the future needs of direct computer-to-computer data transfer.

A comparison of the real-time processing technique and the batch processing technique on a single job basis are comparable, and no significant throughput differences are apparent. But when two or three dozen jobs are being processed by 50 to 100 people on a running basis every day, the time comparison changes dramatically as efficient scheduling in the batch system becomes more and more difficult.

The most important factor in the total NAL computer system throughput analysis is that of user preparation, machine-readable data preparation, and computer job scheduling. A batch processing system operating on a complete cyclic basis (servicing all job requirements on a daily routine) might provide a turnaround time in the neighborhood of two hours to 24 hours. A real-time

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processing system operating on the same basis might provide responses on the order of two minutes to 20 minutes.

(3) System A -- Real Time to All Users

1. General Description

This configuration provides for a real-time data processing system communicating directly with approximately 55 to 60 terminals. Each major section of NAL is to be provided with adequate numbers and types of terminal equipment to maintain a normal workload as projected through 1973. The breakdown of equipment at each section is:

Subject Analysis	20 CRT/keyboards 6 typewriters
Circulation Control	2 CRT/keyboards 2 transactions recorders
Acquisitions	4 CRT/keyboards 1 typewriter
Serials Control	4 transaction recorders 1 CRT/keyboard 1 typewriter
Information Retrieval	10 CRT/keyboards 2 typewriters
Administrative	2 CRT/keyboards 2 typewriters

2. File Layouts

In this approach the files are all on-line to the Central Processing Unit, fully accessible on a random basis as indicated:

File	On-Line	
	Disc	Bulk
Programs	x	
Monographs		x
Serial Titles		x
Journal Articles		x
Title		x
Author		x
Report No.	x	
Order No.	x	
Call No.	x	
Thesaurus	x	
Hi-Lo	x	
Descriptor	x	
SDI	x	
L/C-MARC		x
Chem. Abstracts		x
MEDLARS		x
Budgets	x	
Use Factors	x	

3. Equipment Complex

The following is a listing of the major computer components necessary to support this approach:

5	Data cell drives and modules	File Memory
2	Data cell drive controllers	
5	Mag disc drives and modules	
2	Mag disc controllers	
6	Transaction recorders	User I/O Devices
35	CRT/keyboards	
13	Typewriters	
8	Display controllers	
2	Mag tape transceivers	
2	Punched card transceivers	
1	Switchboard	
4	Rented data terminals	
1	128 K memory	Computer Complex
2	Computer main frames	
1	Paging module	
1	Printer and controller	
1	Card reader and controller	
1	Mag tape drive and controller	
1	Card punch and controller	
8	I/O channels	

4. System Budgetary Costs (Five-Year Cumulative)

File Memory	$ 955 K
Computer Complex	1,350 K
User I/O Devices	700 K
Software Development	2,500 K
Data Preparation	75 K
Computer Operating Personnel	170 K
	$5,750 K

Notes:

- Software development costs are based upon 100 man-years of effort at $25 K/man-year
- Computer operator costs are based upon one-shift operation, gradually expanding to five men at $10 K/man-year
- Supervisory software costs are not included in software development.

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5. Scheduling

The following depicts a preliminary schedule for the implementation of System A.

	FY 1	FY 2	FY 3	FY 4	FY 5
Computer Complex	32 K memory	32 K memory	96 K memory	96 K memory	128 K memory
	2 Main Frames	→			
	All Input Equipment	→			
Computer File Memory	1 Data Cells, 2 Discs	2 Data Cells, 3 Discs	3 Data Cells, 3 Discs	4 Data Cells, 4 Discs	5 Data Cells, 5 Discs
User I/O Devices	10 Stations	15 Stations	25 Stations	40 Stations	55 Stations
		Set of Transceivers →			
Software	5 Men	15 Men	25 Men	30 Men	25 Men
Operators	2	3	3	4	5
Cost	$1,400 K	$2,210 K	$3,440 K	$4,700 K	$5,750 K

(4) System B Approach -- Batch Processing

1. General Description

This configuration is based upon batching all user and library staff requirements via a central data processing center. Sequencing of the various jobs through the center must be determined by constant evaluation of priorities in order to establish effective processor loading. Manual file setups, estimated to be about five minutes per job, preceded by data preparation steps, will be necessary between computer runs.

2. File Layouts

In this approach the basic data are on-line to the computer on a continuous basis. All programs and other files are loaded by the operator as each scheduled task is initiated:

File	On-Line		Operator Load
	Disc	Bulk	
Programs	x		
Monographs		x	
Serial Titles		x	
Journal Articles		x	
Title			x
Author			x
Report No.			x
Order No.			x
Call No.			x
Thesaurus			x
Hi-Lo			x
Descriptor			x
SDI			x
L/C-MARC			x
Chem. Abstracts			x
MEDLARS			x
Budgets			x
Use Factors			x

3. Equipment Complex

The following is a listing of the major computer components necessary to support this approach:

4	Data cell drives and modules	File Memory
1	Data cell drive controller	
4	Mag disc drives and modules	
2	Mag disc drive controllers	
2	Mag tape transceivers	User I/O Devices
2	Punched card transceivers	
4	Rented terminals	
1	Switchboard	

1	64 K memory	Computer Complex
1	Computer main frame	
1	Printer and controller	
1	Card reader and controller	
1	Mag tape drive and controller	
1	Card punch and controller	
5	I/O channels	

4. System Budgetary Costs (Five-Year Cumulative)

File Memory	$ 750 K
Computer Complex	700 K
User I/O Devices	180 K
Software Development	1,800 K
Data Preparation	540 K
Computer Operating Personnel	200 K
	$4,170 K

Notes:

- Software development costs are based upon 72 man-years of effort at $25 K/man-year
- Data preparation costs are based upon a one-shift operation, gradually expanding at the end of five years to an equivalent keypunching capacity of 725 cards per hour
- Computer operation costs are based upon one-shift operations, gradually expanded to six men at $10 K/man-year.

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5. Scheduling

The following depicts a preliminary schedule for the implementation of System B.

	FY 1	FY 2	FY 3	FY 4	FY 5
Computer Complex	32 K memory	32 K memory	64 K memory	64 K memory	64 K memory
	1 Main Frame	→			
	All Input Equipment	→			
Computer File Memory	1 Data Cells, 2 Discs	2 Data Cells, 3 Discs	3 Data Cells, 3 Discs	3 Data Cells, 3 Discs	4 Data Cells, 4 Discs
User I/O Devices	X	Set of Transceivers →			
Software	5 Men	10 Men	18 Men	24 Men	15 Men
Operators	2	3	4	5	6
Cost	$1, 030 K	$1, 650 K	$2, 560K	$3, 420 K	$4, 170 K

(5) System C Approach -- Real-Time Processing to Library Staff and Batch Processing to Users

1. General Description

This system is based upon a hybrid arrangement of systems A and B, that is, it provides for on-line terminal equipments capable of supporting internal library functions. Researcher or external user needs will be satisfied in a batch processed manner. The breakdown of terminal equipments at each section of the library is as follows:

Subject Analysis	20 CRT/keyboards 6 typewriters
Circulation Control	2 CRT/keyboards 2 transaction recorders
Acquisitions	4 CRT/keyboards 1 typewriter
Serials Control	4 transaction recorders 1 CRT/keyboard 1 typewriter
Information Retrieval	None
Administrative	2 CRT/keyboards 2 typewriters

2. File Layouts

In this approach the file layout is identical to that required for System A:

File	On-Line	
	Disc	Bulk
Programs	x	
Monographs		x
Serial Titles		x
Journal Articles		x
Title		x
Author		x
Report No.	x	
Order No.	x	
Call No.	x	
Thesaurus	x	
Hi-Lo	x	
Descriptor	x	
SDI	x	
L/C-MARC		x
Chem. Abstracts		x
MEDLARS		x
Budgets	x	
Use Factors	x	

3. Equipment Complex

The following is a listing of the major computer components necessary to support this approach:

5	Data cell drives and modules	File Memory
2	Data cell drive controllers	
4	Mag disc drives and modules	
2	Mag disc drive controllers	
6	Transaction recorders	User I/O Devices
29	CRT/keyboards	
11	Typewriters	
3	Display controllers	
2	Mag tape transceivers	
2	Punched cards transcrivers	
1	Switchboard	
4	Rented data terminals	
1	96 K memory	Computer Complex
2	Computer main frames	
1	Paging module	
1	Printer and controller	
1	Card Reader and Controller	
1	Mag tape drive and controller	
6	I/O channels	

4. System Budgetary Cost (Five-Year Cumulative)

File Memory	$ 930 K
Computer Complex	1, 180 K
User I/O Devices	465 K
Software Development	2, 100 K
Data Preparation	365 K
Computer Operating Personnel	170 K
	$5, 210 K

Notes:

- Software development costs are based upon 84 man-years of effort at $25 K/man-year
- Data preparation costs are based upon one-shift operation, gradually expanding, at the end of five years, to an equivalent keypunching capacity of 400 cards per hour
- Computer operator costs are based upon one-shift operation, gradually expanded to five men at $10 K/man-year.

5. Scheduling

The following depicts a preliminary schedule for the implementation of System C.

	FY 1	FY 2	FY 3	FY 4	FY 5
Computer Complex	32 K memory	32 K memory	64 K memory	64 K memory	96 K memory
	2 Main Frames	→			
	All Input Equipment	→			
Computer File Memory	1 Data Cells, 2 Discs	2 Data Cells, 3 Discs	3 Data Cells, 3 Discs	4 Data Cells, 3 Discs	5 Data Cells, 4 Discs
User I/O	10 Stations	15 Stations	25 Stations	35 Stations	45 Stations
		Set of Transceivers →			
Software	5 Men	12 Men	22 Men	25 Men	20 Men
Operators	2	3	3	4	5
Cost	$1, 370 K	$2, 190 K	$3, 500 K	$4, 400 K	$5, 210 K

(6) System D Approach -- Batch Processing for Library Staff and Real-Time Processing for External Users

1. General Description

This approach is based upon a systems configuration which combines features of Systems A and B in another way. The library functions are off-line to the data processing equipment while the researcher or external user is provided with terminal stations for direct conversation with the machine for real-time information retrieval data. A breakdown of the user terminals is:

Subject Analysis	None
Circulation Control	None
Acquisitions	None
Serials Control	None
Information Retrieval	10 CRT/keyboards 2 typewriters
Administrative	None

2. File Layouts

The justification for this approach would tend to lie in the cost of user terminals since the main computer system and software development costs tend to approximate those of the first approach. The file layout shows this trend:

File	On-Line		Operator Load
	Disc	Bulk	
Programs	x		
Monographs		x	
Serial Titles		x	
Journal Articles		x	
Title		x	
Author		x	
Report No.	x		
Order No.	x		
Call No.	x		
Thesaurus	x		
Hi-Lo	x		
Descriptors	x		
SDI			x
L/C-MARC		x	
Chem. Abstract		x	
MEDLARS		x	
Budgets			x
Use Factors			x

3. Equipment Complex

The following is a listing of the major computer components necessary to support the approach:

5	Data cell drives and modules	File Memory
2	Data cell drive controllers	
4	Mag disc drives and modules	
2	Mag disc drive controllers	
10	CRT/keyboards	User I/O Devices
3	Typewriters	
2	Display controllers	
2	Mag tape transceivers	
2	Punched card transceivers	
1	Switchboard	
4	Rented terminals	
1	96 K memory	Computer Complex
1	Computer	
1	Paging module	
6	I/O channels	
1	Printer and controller	
1	Card reader and controller	
1	Mag tape drive and controller	
1	Card punch and controller	

4. System Budgetary Costs (Five-Year Cumulative)

File Memory	$ 870 K
Computer Complex	980 K
User I/O Devices	300 K
Software Development	1,900 K
Data Preparation	480 K
Computer Operating Personnel	200 K
	$4,730 K

Notes:

- Software development costs are based upon 76 man-years of effort at $25 K/man-year
- Data preparation costs are based upon one-shift operation, gradually expanding to an equivalent capacity of 600 cards per hour at the end of five years
- Computer operator costs are based upon one-shift operations, gradually expanding to six men at $10 K/man year.

5. Scheduling

The following depicts a preliminary schedule for the implementation of System D.

	FY 1	FY 2	FY 3	FY 4	FY 5
Computer Complex	32 K memory	32 K memory	64 K memory	64 K memory	96 K memory
	1 Main Frame	→			
	All Input Equipment	→			
Computer File Memory	1 Data Cell, 2 Discs	2 Data Cells, 3 Discs	3 Data Cells, 3 Discs	4 Data Cells, 3 Discs	5 Data Cells, 4 Discs
User I/O	2 Stations	5 Stations	8 Stations	10Stations	12 Stations
		Set of Transceivers →			
Software	5 Men	10 Men	20 Men	25 Men	16 Men
Operators	2	3	4	5	6
Cost	$1, 120 K	$1, 960 K	$3, 000 K	$3, 000 K	$4, 730 K

4. EFFECT OF MECHANIZATION ON ORGANIZATION AND MANPOWER

The organization of the NAL has been analyzed from two points of view:

- Structural changes that would permit a more efficient utilization of the computer system
- Manpower changes indicated by shifting skill needs.

Because a detailed organizational study forms a part of the second phase of the project, only the recommended major functional changes are discussed in this report. (The specific computer sub-organization, however, is described in more detail.) While these changes could be carried out within the present manual NAL, their disruptive effect on manpower organization and workload may exceed the attendant gain in efficiency. The changes proposed are:

- Restructure the Division of Cataloging and the Bibliography of Agriculture project, and assign descriptive cataloging responsibilities to the Division of Acquisitions.

  The Division of Acquisitions within the present NAL has the responsibility of selecting and ordering publications for addition to NAL collection. For citations selected from bibliographies, acquisitions staff members create an order which consists, among other things, of the basic bibliographic information contained in the printed citation. Later, when the publication arrives and is checked in, it is given to the Division of Cataloging where a new record is created -- the official record as it will appear in the

NAL catalog. This record differs from the original order record in the amount of information that is recorded and to the extent that the corporate and personal author authority forms differ from the original citation. In addition, a subject analysis is performed, resulting in the adding of subject headings and a classification number. Until this cataloging function is performed, the Acquisitions order form is used as a temporary record. After cataloging, this temporary record is replaced by the official catalog card.

Like the present NAL, a computer-supported NAL will require a record of publication from the time it is initially ordered. This record must be easily available for reference by any part of the NAL. Therefore, we propose that the initial record creation be accomplished using the cataloging rules to the extent that the information used in ordering will be suitable as a start for the official NAL record, and no retranscription or reformatting of it will be required. When an ordered publication is received, Acquisitions can complete the descriptive cataloging for the record. The effect of this step is to delete descriptive cataloging as a separate function and to integrate it with Acquisitions.

- Create a Subject Analysis Division with responsibilities for both subject cataloging and indexing for the Bibliography of Agriculture.

Subject cataloging is now performed in the Division of Cataloging by professional staff members on the basis of subject within language, provided the manpower skills are available -- if not, then the basis is language only. The subject catalogers use NAL subject categories from the NAL vocabulary. Detailed subject indexing is not done by the catalogers. Journal articles to which such indexing is normally applied is not analyzed by the catalogers. Instead, items to be subject indexed are sent to the Bibliography of Agriculture project where indexing is performed also by subject within language specialty.

Our design of a mechanized NAL combines both general and specific subject analysis, depending upon the nature of the material being analyzed. We believe, however, that the functions of subject cataloging and indexing should be performed by the same group, and accordingly, we propose to create a Subject Analysis Division. This division will be the integration of the subject cataloging portion of the Cataloging Division and the indexing part of the Bibliography of Agriculture project.

- Replace the Division of Reference with a new Division of Information Retrieval with responsibility for all bibliographic retrievals.

The Division of Reference now performs a limited number of demand searches but prepares no other type of bibliographies. We propose to expand and retitle the Division to handle all search queries and prepare all bibliographies (except Pesticides). Thus, the new Division of Information would develop the retrievals for the Bibliography of Agriculture, demand, recurrent, and special bibliographies, and selective dissemination of information notifications. This recommendation would centralize the manpower talent and equipment required in forming query strategies for machine processing.

- Create a new Publications Division with the responsibility for producing all NAL printed outputs for external distribution.

As the responsiveness of the NAL to research needs increases, the demand upon NAL's services may also be expected to increase. Some of these services, in addition to the Bibliography of Agriculture and the Pesticides Information Bulletin, will require high quality printing. This printing could be accomplished by the Government Printing Office (GPO) on their new Linotron machine, but input to this machine must be via preformated magnetic tape. The responsibility of a new Division of Publications will be to edit, format, and otherwise prepare the retrieval outputs from the Division of Information Retrieval such as the Bibliography of Agriculture. The Division will also carry out the distribution of the printed materials.

- Create a Division of Systems and Programming, and a Division of Operations to report to an Assistant Director for Systems Support Services.

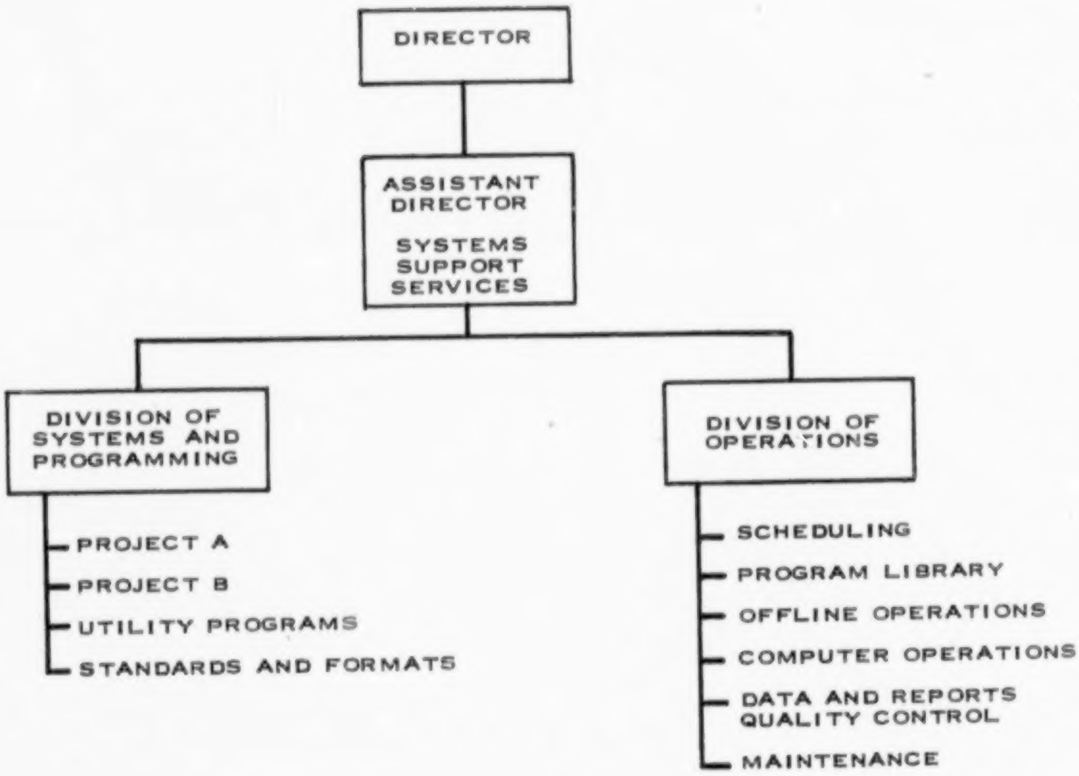
The former division will have responsibility for all computer programming, formats, and input/output standards. In addition, it will provide programmers and analysts on a project organization basis to each NAL division as required during the implementation period. The operating division will be responsible for all machine operation, job scheduling, and input/output quality control.

Figure III-1 illustrates the recommended organization for the computer system. The two divisions representing programming and operations are indicated reporting to a new Assistant Director. We recommend this arrangement to help avoid a tendency for another NAL division to develop a bias or control over the computer organization. On the other hand, we strongly recommend against the provision of the services of these two divisions from outside of the NAL organization. The typical experience of libraries with such outside computer support has been consistently poor due to both the inability to control scheduling and priorities and the lack of understanding on the part of the outside programmers of the library's environment.

- Provide a staff function reporting to the Director to evaluate the NAL's operating effectiveness and prepare plans for system modifications and upgrading.

In order to derive the most benefit from the new NAL system, we suggest that a staff function be created to review and evaluate the system effectiveness. To improve the objectivity of this function, we believe it should report directly to the Director. Plans, general programs, and system modifications should also be performed by this function. Primary data for function will be the system's operating statistics (which are developed automatically by the computer) and user response and criticism.

FIGURE III-1
Proposed NAL Organizational Structure


DIRECTOR
ASSISTANT DIRECTOR
SYSTEMS SUPPORT SERVICES
DIVISION OF SYSTEMS AND PROGRAMMING
PROJECT A
PROJECT B
UTILITY PROGRAMS
STANDARDS AND FORMATS
DIVISION OF OPERATIONS
SCHEDULING
PROGRAM LIBRARY
OFFLINE OPERATIONS
COMPUTER OPERATIONS
DATA AND REPORTS QUALITY CONTROL
MAINTENANCE

5. MECHANIZED FUNCTIONAL OPERATIONS

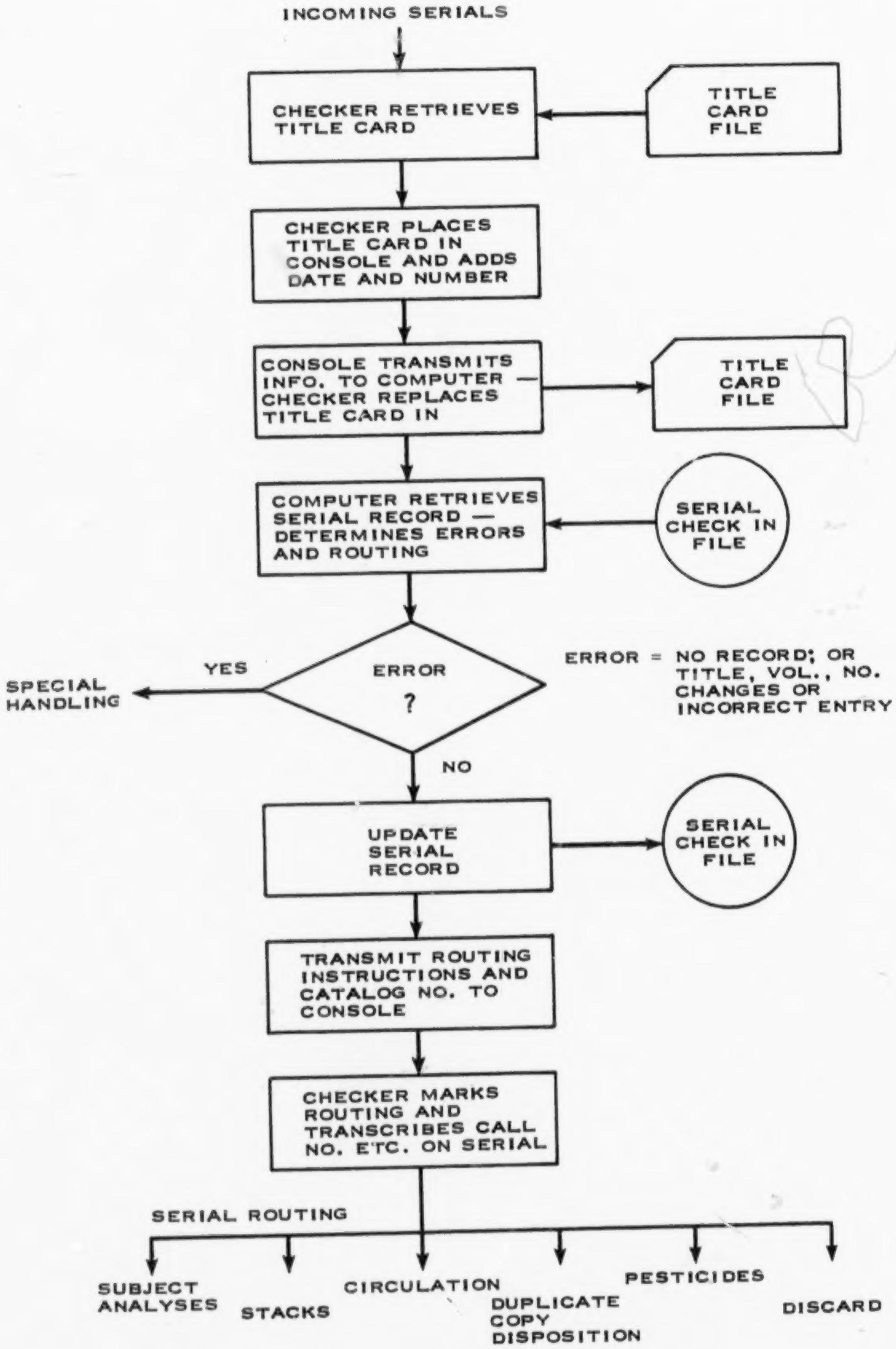
This section analyzes the operation of the alternative design approaches as they appear to the NAL librarian-operators in their own functional areas.

(1) Serials Control Function: On-Line System

Figure III-2 illustrates the logical flow of the On-Line Serials Control System. The system is organized on the premise that the majority of serials can be handled routinely without special attention. A single manual file of durable machine-readable title cards is used by the Checker to identify the publication to be checked in. The Checker's only machine manipulation is to indicate on a processing console the date and number of the serial and to insert the appropriate title card. Serials requiring special attention because of a title change, numbering change, etc., are immediately removed from the routine flow and handled by a Special Checker (Figure III-3). The Special Checker is provided a keyboard/display console to visually access the master files maintained in the computer.

The serial check-in process is envisioned to proceed as follows:

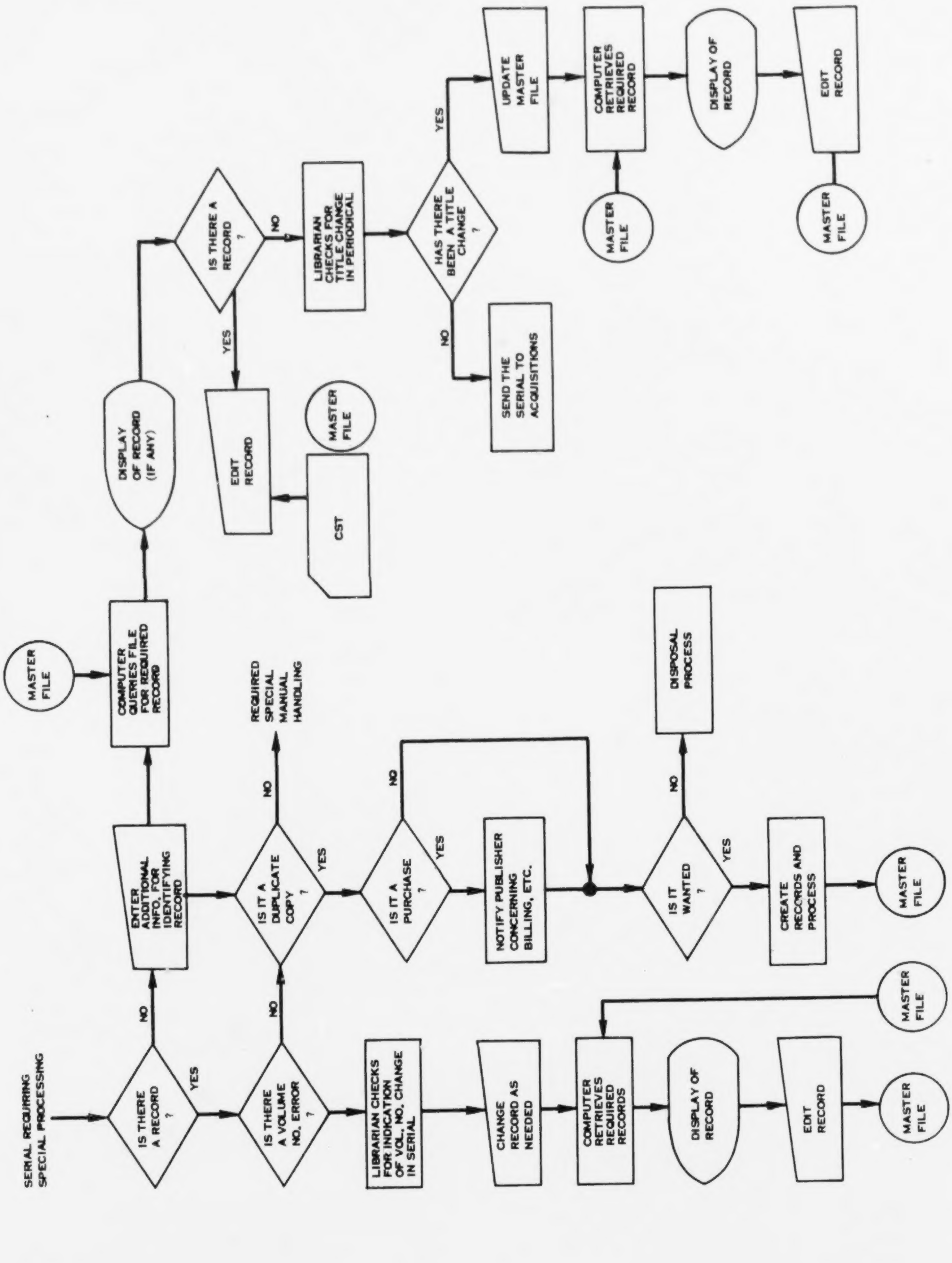
FIGURE III-2
Serials Control Function:
On-Line System


INCOMING SERIALS
CHECKER RETRIEVES TITLE CARD
TITLE CARD FILE
CHECKER PLACES TITLE CARD IN CONSOLE AND ADDS DATE AND NUMBER
CONSOLE TRANSMITS INFO. TO COMPUTER — CHECKER REPLACES TITLE CARD IN
TITLE CARD FILE
COMPUTER RETRIEVES SERIAL RECORD — DETERMINES ERRORS AND ROUTING
SERIAL CHECK IN FILE
ERROR ?
YES
SPECIAL HANDLING
ERROR = NO RECORD; OR TITLE, VOL., NO. CHANGES OR INCORRECT ENTRY
NO
UPDATE SERIAL RECORD
SERIAL CHECK IN FILE
TRANSMIT ROUTING INSTRUCTIONS AND CATALOG NO. TO CONSOLE
CHECKER MARKS ROUTING AND TRANSCRIBES CALL NO. ETC. ON SERIAL
SERIAL ROUTING
SUBJECT ANALYSES
STACKS
CIRCULATION
DUPLICATE COPY DISPOSITION
PESTICIDES
DISCARD

BATCH PROCESS OUTPUTS

- SERIAL TITLES RECEIVED IN NAL
- SERIAL ROUTING LIST
- NEW TITLE ACQUISITIONS
- CLAIM LIST (AND NOTICE)
- RENEWAL LIST (AND NOTICE)
- SERIAL TITLES LISTED BY GEOGRAPHIC AREA AND BY LANGUAGE
- UPDATED SERIAL RECORD FILE
- SERIAL TITLES BY FREQUENCY OF ISSUE
- SERIAL TITLES BY PUBLISHER OR INSTITUTION
- SERIAL TITLES BY SUBJECT CATEGORY
- SERIAL HOLDINGS BY TITLE
- CIRCULATION ROUTING LISTS

FIGURE III-3
Serial Control Function
(Special Handling): On-Line


SERIAL REQUIRING SPECIAL PROCESSING
IS THERE A RECORD ?
YES
NO
IS THERE A VOLUME NO. ERROR ?
NO
LIBRARIAN CHECKS FOR INDICATION OF VOL. NO. CHANGE IN SERIAL
CHANGE RECORD AS NEEDED
COMPUTER RETRIEVES REQUIRED RECORDS
MASTER FILE
DISPLAY OF RECORD
EDIT RECORD
MASTER FILE
ENTER ADDITIONAL INFO. FOR IDENTIFYING RECORD
IS IT A DUPLICATE COPY ?
NO
REQUIRED SPECIAL MANUAL HANDLING
YES
IS IT A PURCHASE ?
NO
YES
NOTIFY PUBLISHER CONCERNING BILLING, ETC.
IS IT WANTED ?
NO
DISPOSAL PROCESS
YES
CREATE RECORDS AND PROCESS
MASTER FILE
MASTER FILE
COMPUTER QUERIES FILE FOR REQUIRED RECORD
DISPLAY OF RECORD (IF ANY)
IS THERE A RECORD ?
YES
EDIT RECORD
CST
MASTER FILE
NO
LIBRARIAN CHECKS FOR TITLE CHANGE IN PERIODICAL
HAS THERE BEEN A TITLE CHANGE ?
NO
SEND THE SERIAL TO ACQUISITIONS
YES
UPDATE MASTER FILE
COMPUTER RETRIEVES REQUIRED RECORD
MASTER FILE
DISPLAY OF RECORD
EDIT RECORD
MASTER FILE

- The Checker receives an incoming serial and retrieves the corresponding title card from the Title Card File. This file is similar to the present CSR except that each Checker is provided with a complete file instead of only a portion, and the file cards contain only title information. The present technique used to locate the file card will be continued.

- After locating the title card, the Checker inserts it in a console. He then adds the publication date and number by the appropriate machine manipulation.

- The console transmits this information plus the day's date and time to the computer. The computer locates the serial's master file record, enters the check-in information, determines the serial's routing, and signals this routing to the console for the Checker's needed information (e.g., circulation, stacks, etc.).

  If an abnormal situation is detected by the computer or the Checker, such as a title or number change, or an incorrect entry, the computer then signals the Checker to stop processing and deliver the serial to the Special Checker.

- The Checker then transcribes the serial's call number onto the cover and routes it to the next destination.

As in the other systems, the routine file updating, statistics maintenance, and preparation of summary listings are accomplished automatically by the computer. A partial list of these is shown on the flow diagram.

(2) Serials Control Function: Batch Process System

The batch process alternative for the Serials Control System has basically the same flow as the on-line alternative. In the batch process system the Serial Title Card is a five-inch by eight-inch card with machine-readable punchings along the bottom edge. These punchings contain the title and can be read by a punched paper tape machine such as a Flexowriter. Instead of transactions of the check-in being checked against the master file as they occur, the day's transactions are accumulated on paper tape and processed by the computer during an evening shift or the next day.

Operation of the batch process system is illustrated in Figure III-4 and is described as follows:

- The Checker retrieves the proper title card from the Title Card File. He makes a visual check to verify the title, year, numbering system, etc., of the serial. (If these data do not correspond, the Checker immediately withdraws the serial with its title card and gives it to the Special Checker for special handling.)
- The Checker then transcribes the catalog number, routing, etc. on the issue.

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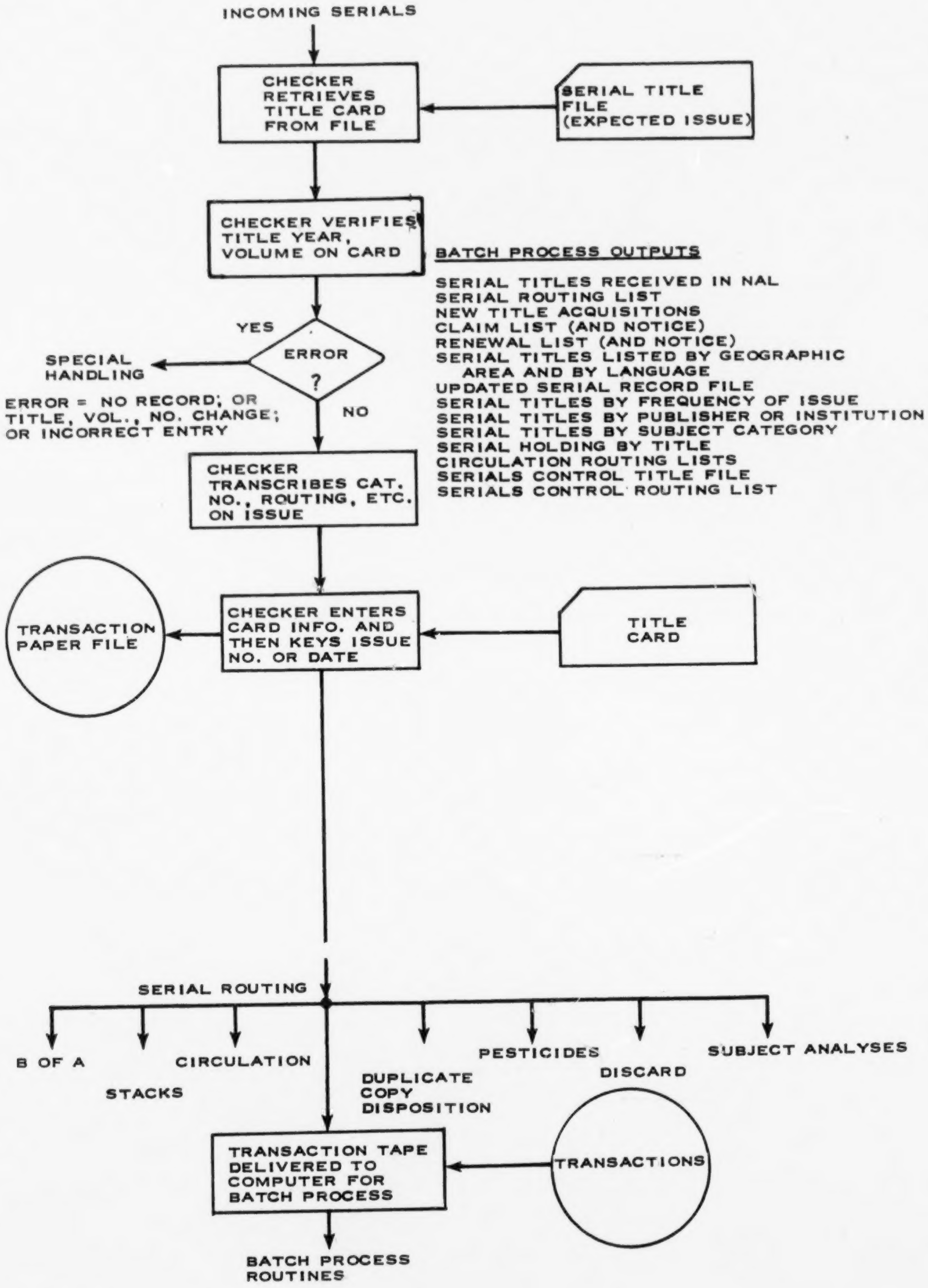
FIGURE III-4
Serial Control Function:
Batch Process System


INCOMING SERIALS
CHECKER RETRIEVES TITLE CARD FROM FILE
SERIAL TITLE FILE (EXPECTED ISSUE)
CHECKER VERIFIES TITLE YEAR, VOLUME ON CARD
BATCH PROCESS OUTPUTS
SERIAL TITLES RECEIVED IN NAL
SERIAL ROUTING LIST
NEW TITLE ACQUISITIONS
CLAIM LIST (AND NOTICE)
RENEWAL LIST (AND NOTICE)
SERIAL TITLES LISTED BY GEOGRAPHIC AREA AND BY LANGUAGE
UPDATED SERIAL RECORD FILE
SERIAL TITLES BY FREQUENCY OF ISSUE
SERIAL TITLES BY PUBLISHER OR INSTITUTION
SERIAL TITLES BY SUBJECT CATEGORY
SERIAL HOLDING BY TITLE
CIRCULATION ROUTING LISTS
SERIALS CONTROL TITLE FILE
SERIALS CONTROL ROUTING LIST
YES
ERROR ?
SPECIAL HANDLING
ERROR = NO RECORD; OR TITLE, VOL., NO. CHANGE; OR INCORRECT ENTRY
NO
CHECKER TRANSCRIBES CAT. NO., ROUTING, ETC. ON ISSUE
TRANSACTION PAPER FILE
CHECKER ENTERS CARD INFO. AND THEN KEYS ISSUE NO. OR DATE
TITLE CARD
SERIAL ROUTING
B OF A
STACKS
CIRCULATION
DUPLICATE COPY DISPOSITION
PESTICIDES
DISCARD
SUBJECT ANALYSES
TRANSACTION TAPE DELIVERED TO COMPUTER FOR BATCH PROCESS
TRANSACTIONS
BATCH PROCESS ROUTINES

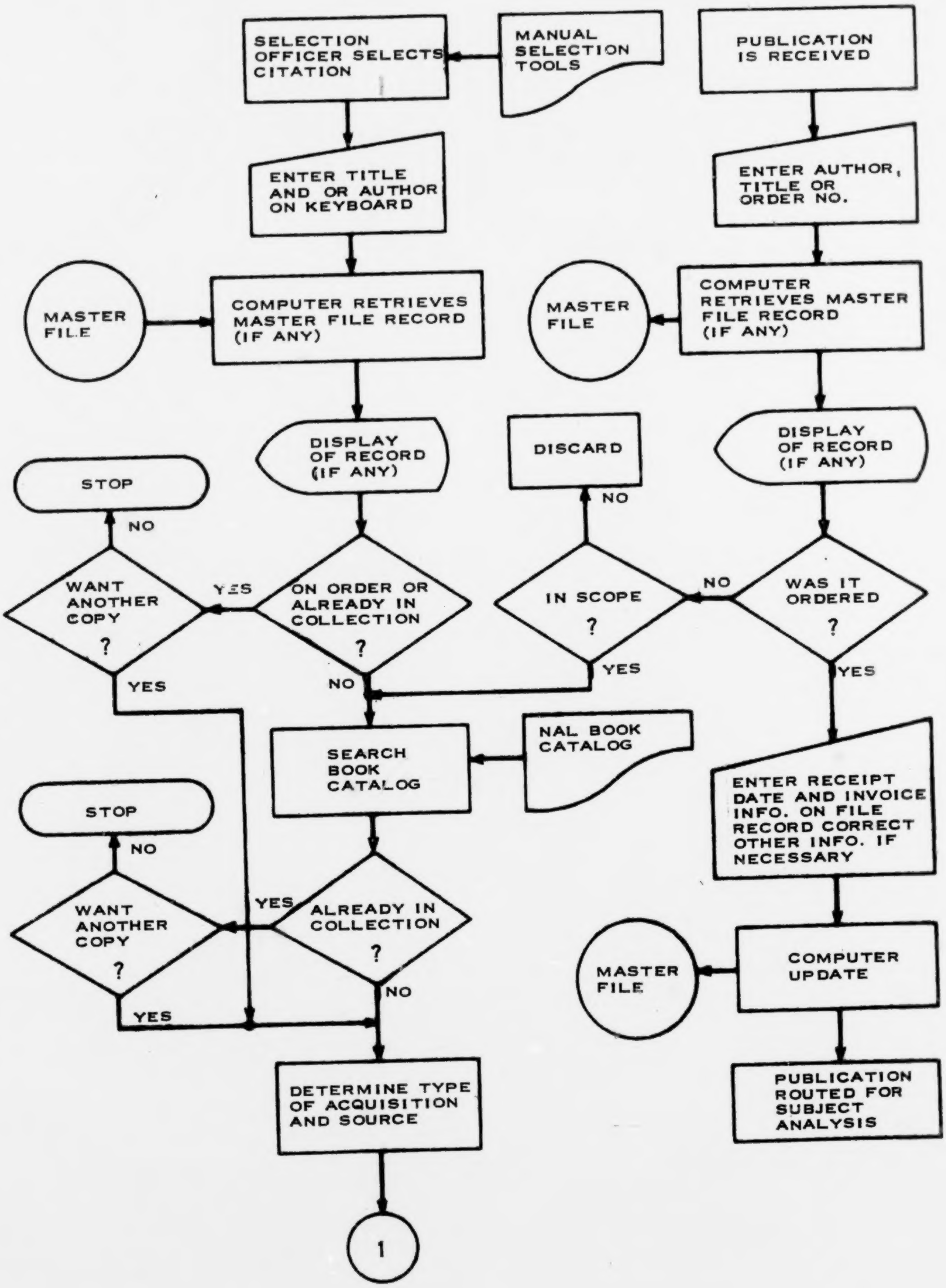
- Using the title card's machine-readable edges, the Checker then creates a paper tape record of the title with equipment such as a Flexowriter. He adds receipt date, issue date, and number using the keyboard.
- The issue is then routed and the transaction tape added to the day's accumulation.
- At the end of the day the transaction tapes are taken to the computer for file updating, statistics, generation of claim notices, renewal notifications, listings, etc.

(3) Acquisitions Function: On-Line System

Figure III-5 illustrates the On-Line alternative design we have prepared for the Acquisitions system. The most significant difference between this system and the present system (besides the keyboard file references), is the addition of the function of descriptive cataloging. This addition was made to gain two important advantages:

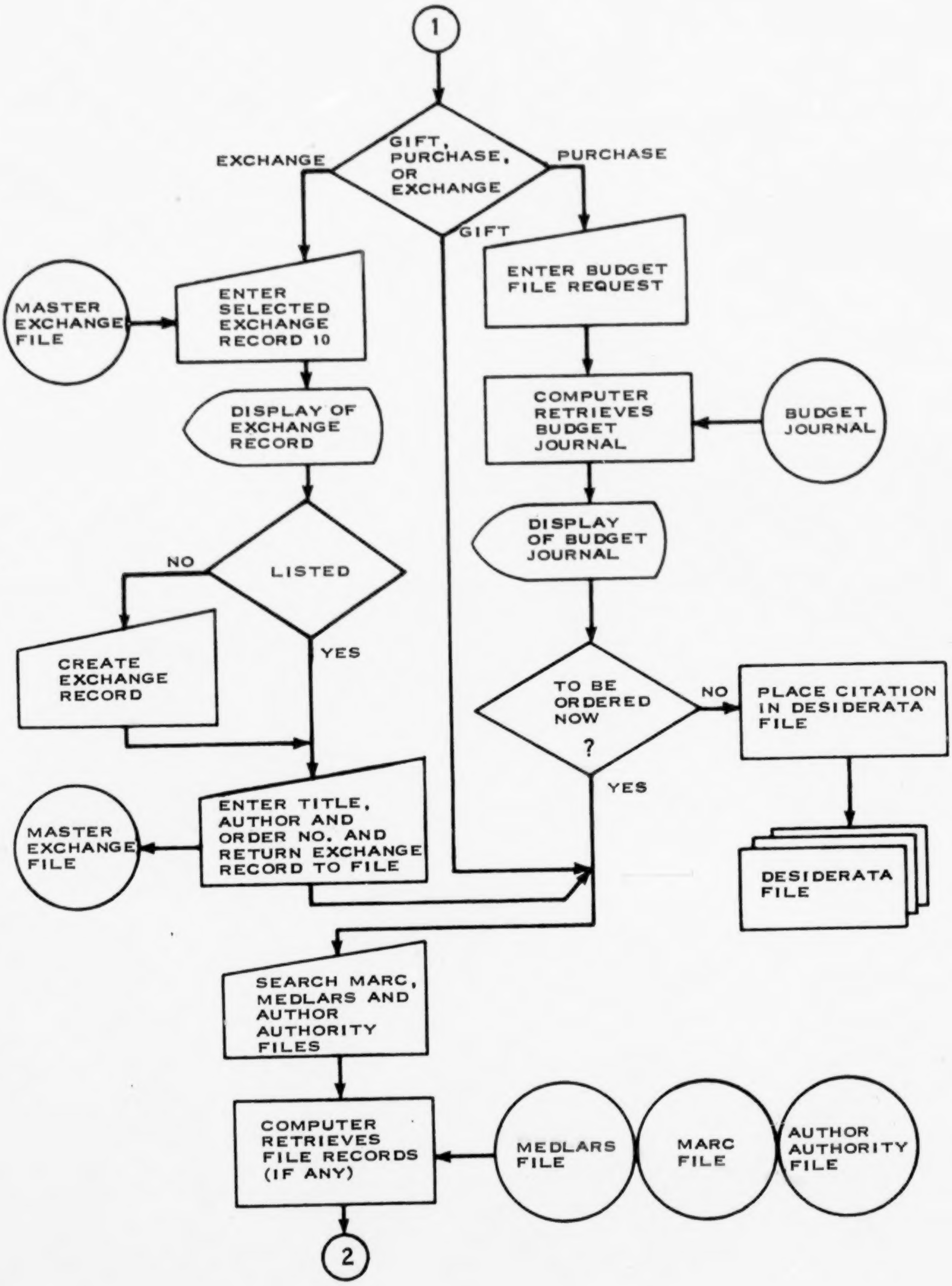
- To insure that the initial Master File record creation is done correctly in standard format so that all other elements in NAL can have immediate access to it as the official record.
- To eliminate the record recopying step required if the descriptive cataloging operation were separate.

FIGURE III-5
Acquisition Function:
On-Line System


SELECTION OFFICER SELECTS CITATION
MANUAL SELECTION TOOLS
PUBLICATION IS RECEIVED
ENTER TITLE AND OR AUTHOR ON KEYBOARD
ENTER AUTHOR, TITLE OR ORDER NO.
MASTER FILE
COMPUTER RETRIEVES MASTER FILE RECORD (IF ANY)
MASTER FILE
COMPUTER RETRIEVES MASTER FILE RECORD (IF ANY)
DISPLAY OF RECORD (IF ANY)
DISCARD
DISPLAY OF RECORD (IF ANY)
STOP
NO
NO
WANT ANOTHER COPY ?
YES
ON ORDER OR ALREADY IN COLLECTION ?
IN SCOPE ?
NO
WAS IT ORDERED ?
YES
NO
YES
YES
NAL BOOK CATALOG
SEARCH BOOK CATALOG
ENTER RECEIPT DATE AND INVOICE INFO. ON FILE RECORD CORRECT OTHER INFO. IF NECESSARY
STOP
NO
YES
WANT ANOTHER COPY ?
ALREADY IN COLLECTION ?
NO
YES
MASTER FILE
COMPUTER UPDATE
DETERMINE TYPE OF ACQUISITION AND SOURCE
PUBLICATION ROUTED FOR SUBJECT ANALYSIS
1

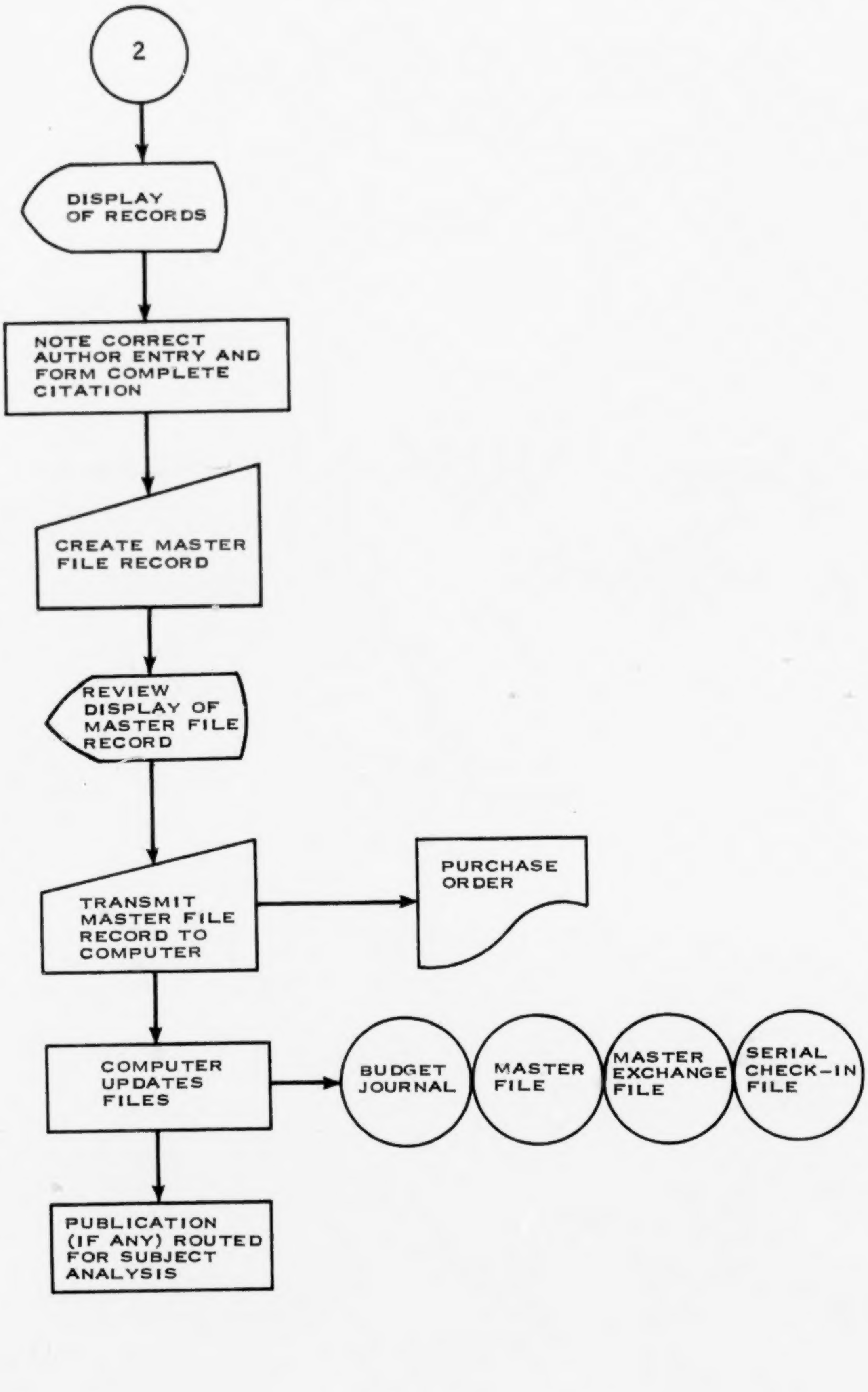
BAARINC

FIGURE III-5a
Acquisition Function:
On-Line System (cont.)


1
GIFT, PURCHASE, OR EXCHANGE
EXCHANGE
PURCHASE
GIFT
MASTER EXCHANGE FILE
ENTER SELECTED EXCHANGE RECORD 10
ENTER BUDGET FILE REQUEST
DISPLAY OF EXCHANGE RECORD
COMPUTER RETRIEVES BUDGET JOURNAL
BUDGET JOURNAL
DISPLAY OF BUDGET JOURNAL
NO
LISTED
YES
CREATE EXCHANGE RECORD
TO BE ORDERED NOW ?
NO
YES
PLACE CITATION IN DESIDERATA FILE
DESIDERATA FILE
MASTER EXCHANGE FILE
ENTER TITLE, AUTHOR AND ORDER NO. AND RETURN EXCHANGE RECORD TO FILE
SEARCH MARC, MEDLARS AND AUTHOR AUTHORITY FILES
COMPUTER RETRIEVES FILE RECORDS (IF ANY)
MEDLARS FILE
MARC FILE
AUTHOR AUTHORITY FILE
2

BAARINC

FIGURE III-5b
Acquisition Function:
On-Line System (cont.)


2
DISPLAY OF RECORDS
NOTE CORRECT AUTHOR ENTRY AND FORM COMPLETE CITATION
CREATE MASTER FILE RECORD
REVIEW DISPLAY OF MASTER FILE RECORD
TRANSMIT MASTER FILE RECORD TO COMPUTER
PURCHASE ORDER
COMPUTER UPDATES FILES
BUDGET JOURNAL
MASTER FILE
MASTER EXCHANGE FILE
SERIAL CHECK-IN FILE
PUBLICATION (IF ANY) ROUTED FOR SUBJECT ANALYSIS

The following paragraphs describe the On-Line system in comparison to the present manual system:

- Following the selection of the citation, an Acquisitions librarian searches the Master File via a keyboard/display console and the old section of the Public Catalog via the NAL Book Catalog located at his work area. In the present system, the ASF, CSR, AOF, and Public Catalog (all in different locations) are manually searched.

- After determining that the selected citation is not already on order or in the collection, the librarian next selects the prospective source for the citation. If a purchase is required, an examination of the Budget Journal is made to determine funds available for purchase. This examination is done using a keyboard/display console. The Journal record so retrieved is an accurate up-to-the-minute official expression of the allocation balance. In comparison to the presently used manual Cuff File it not only contains order allocations but also actual invoiced expenditures.

- If the Acquisitions librarian decides to order the citation, the order is prepared following a descriptive cataloging routine. (In the present system this step of cataloging is done after the item is received and sent to the Cataloging Section.) The first step in preparing the order is to search the Library of Congress MARC File and the National Library of Medicine MEDLARS File to see if the citation has already been cataloged. This search is also accomplished via a keyboard/display console. If LC or NLM cataloging information is located, the pertinent descriptive information is marked off on the display and then stored to form the initial Master File record for the citation. If necessary, the Corporate Author Authority File is searched via a keyboard/display console to obtain the NAL standard form for the corporate author. (This authority reference is currently a manual search in the Cataloging Section's work with an item after it is received.)

- Using the citation reference, the NLM and LC cataloging information, the authority reference, and any related information from the NAL Master File or old Public Catalog (printed), the complete citation is formed on a keyboard/display console. When complete, this record becomes the Master File entry for the item and is transmitted to the computer for placement in the Master File for use by other NAL elements. Simultaneously with transmission, a Purchase Order is printed out at the Acquisitions location using a preselected portion of the Master File record information. In the present system the above steps without the cataloging references are accomplished by manually preparing a form LF 317, photographing it with various masks, and distributing it to update the various files (CSR, AOF, OOF, Budget, Public Catalog).

- When an item is received from the vendor or exchange source, it is checked in by entering the order number or title on a keyboard/display console and querying the Master File. If it was in fact ordered, the item's record will be displayed for the purpose of verification and to have receipt and invoice information added. The item itself is then routed for subject cataloging and indexing. In the present system the same work is accomplished by manually searching and updating the OOF and AOF files and notifying the Budget Section.

File maintenance and the publication of summary listings and notifications will be done in a batch processing step on a predetermined schedule. Included in these are updating the budget files and the Master Exchange File, the listing of new acquisitions, new serial titles, serial renewals due, and Acquisitions Statistics, and the creations of claim notices and serial renewal requests.

(4) Acquisitions Function: Batch Process System

Figure III-6 illustrates the application of computer batch processing to the Acquisitions function. This design is based upon our analysis of the present NAL Acquisitions Division.

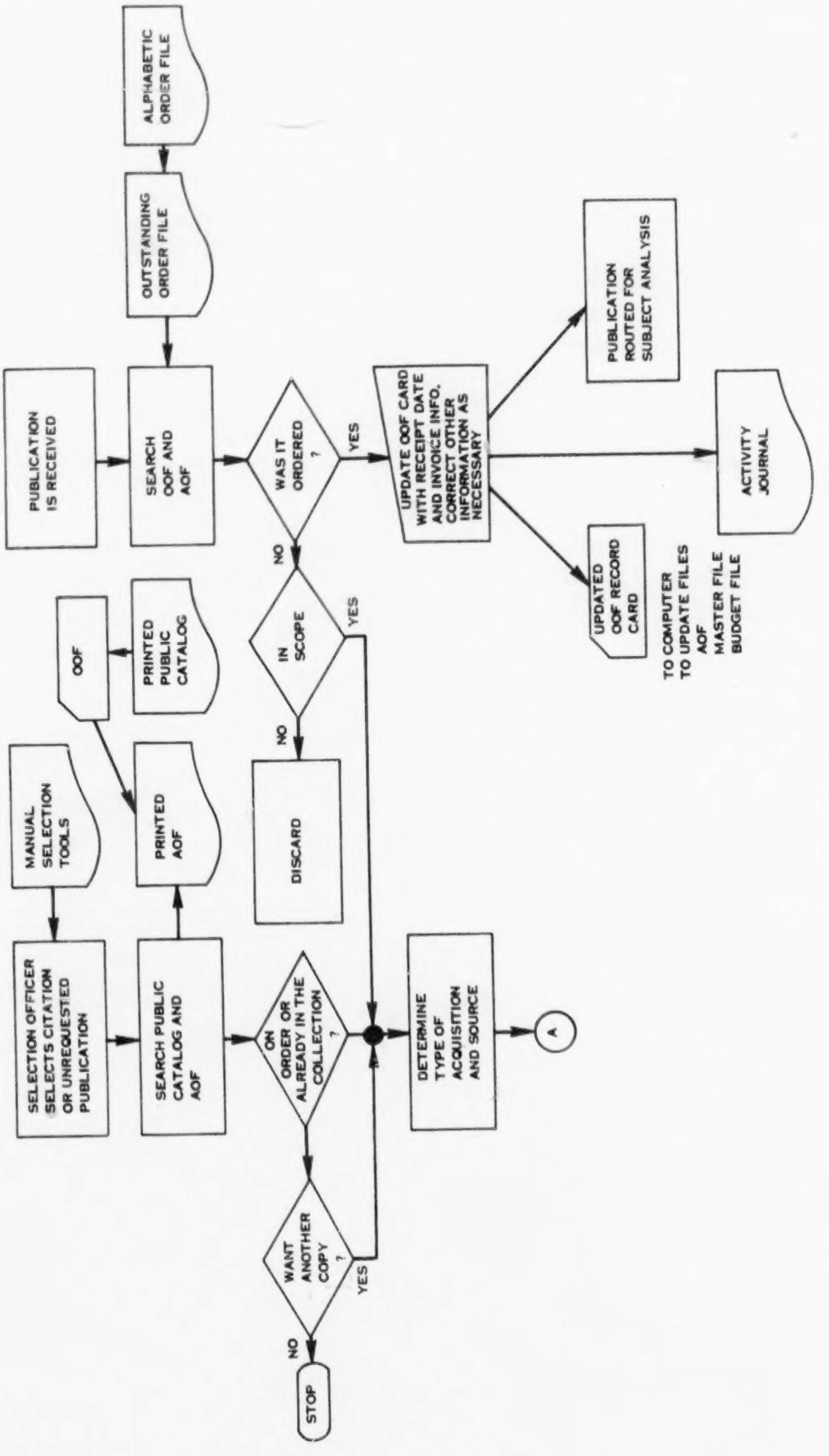
As in our design of the On-Line System approach, however, we have added the descriptive cataloging operation at the point where the original NAL record of a publication is created.

The flow chart is confined to the primary operation and those aspects that receive computer assistance.

In this system, the AOF and Public Catalog (new section) is computer maintained and printed and the OOF is a file of punched cards.

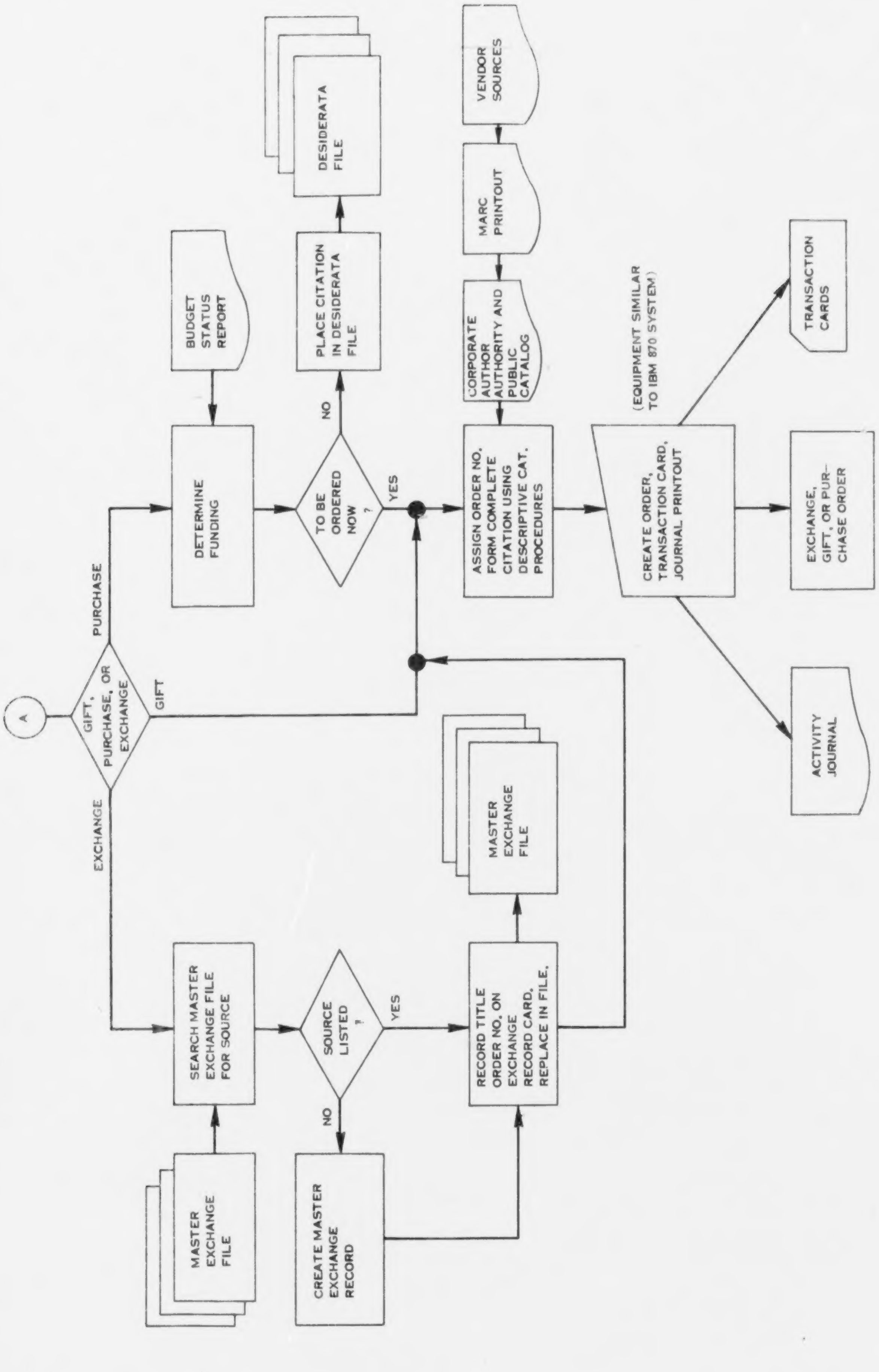
The Master Exchange File is unchanged from its present form. The manual Cuff File (used for informally determining the budget expenditure status) is replaced by a computer-printed Budget Status Report. The descriptive cataloging step (not included in the present manual Acquisitions function) is aided by computer printouts of the Library of Congress MARC project and the printed Public Catalog. An important feature of the system is the use of order preparation equipment that

FIGURE III-6
Acquisition Function:
Batch Process System


PUBLICATION IS RECEIVED
SEARCH OOF AND AOF
OUTSTANDING ORDER FILE
ALPHABETIC ORDER FILE
WAS IT ORDERED ?
YES
NO
UPDATE OOF CARD WITH RECEIPT DATE AND INVOICE INFO. CORRECT OTHER INFORMATION AS NECESSARY
PUBLICATION ROUTED FOR SUBJECT ANALYSIS
ACTIVITY JOURNAL
UPDATED OOF RECORD CARD
TO COMPUTER TO UPDATE FILES AOF MASTER FILE BUDGET FILE
IN SCOPE
YES
NO
DISCARD
MANUAL SELECTION TOOLS
OOF
PRINTED PUBLIC CATALOG
PRINTED AOF
SELECTION OFFICER SELECTS CITATION OR UNREQUESTED PUBLICATION
SEARCH PUBLIC CATALOG AND AOF
ON ORDER OR ALREADY IN THE COLLECTION ?
DETERMINE TYPE OF ACQUISITION AND SOURCE
A
WANT ANOTHER COPY ?
YES
NO
STOP

BAARINC

FIGURE III-6
Continued


A
GIFT, PURCHASE, OR EXCHANGE
PURCHASE
GIFT
EXCHANGE
DETERMINE FUNDING
BUDGET STATUS REPORT
TO BE ORDERED NOW ?
NO
YES
PLACE CITATION IN DESIDERATA FILE
DESIDERATA FILE
ASSIGN ORDER NO. FORM COMPLETE CITATION USING DESCRIPTIVE CAT. PROCEDURES
CORPORATE AUTHOR AUTHORITY AND PUBLIC CATALOG
MARC PRINTOUT
VENDOR SOURCES
CREATE ORDER, TRANSACTION CARD, JOURNAL PRINTOUT
(EQUIPMENT SIMILAR TO IBM 870 SYSTEM)
TRANSACTION CARDS
EXCHANGE, GIFT, OR PURCHASE ORDER
ACTIVITY JOURNAL
SEARCH MASTER EXCHANGE FILE FOR SOURCE
MASTER EXCHANGE FILE
SOURCE LISTED ?
YES
NO
CREATE MASTER EXCHANGE RECORD
RECORD TITLE ORDER NO. ON EXCHANGE RECORD CARD, REPLACE IN FILE.
MASTER EXCHANGE FILE

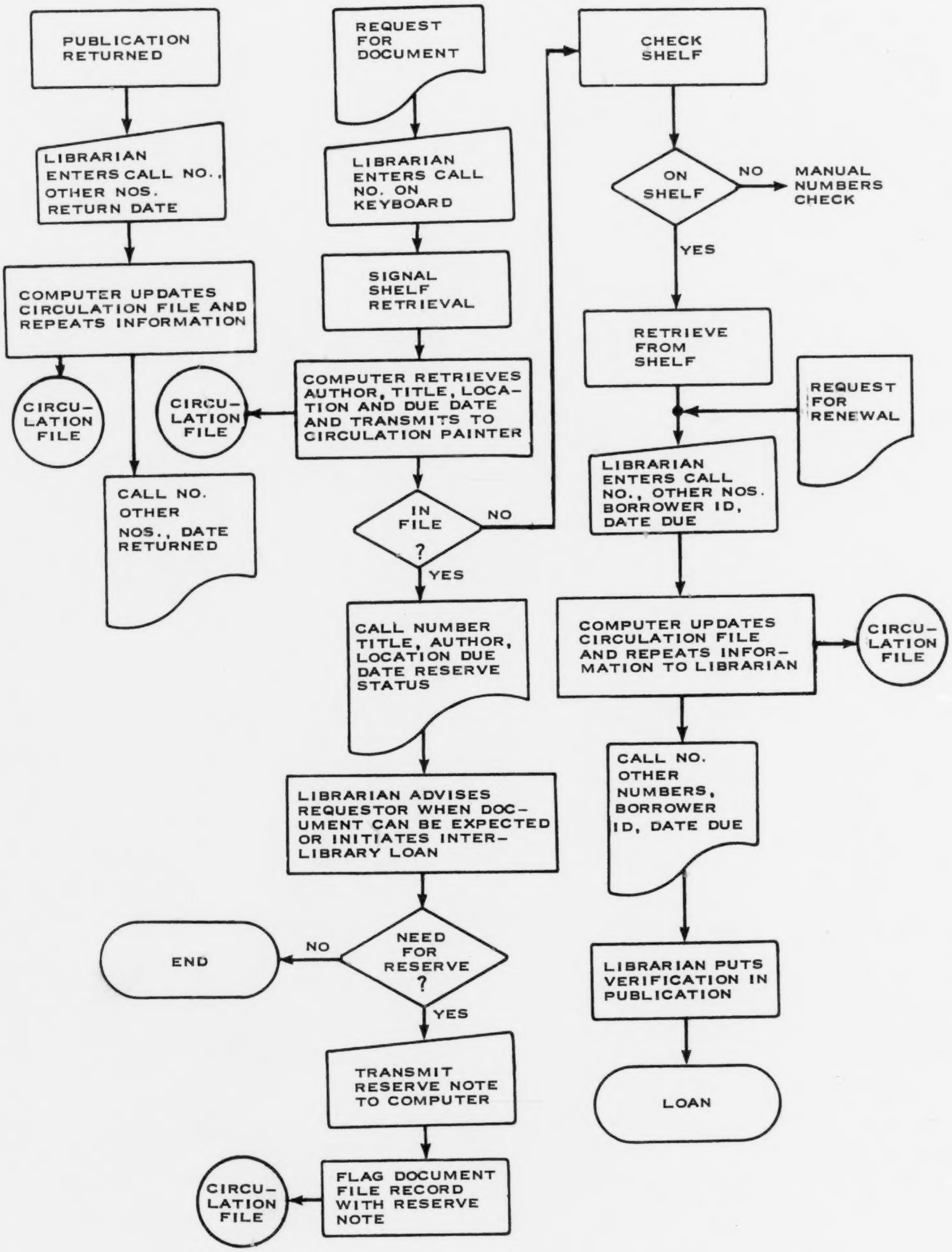
simultaneously produces a punched card. An example of this type of equipment is the IBM 870 Document Writing System which permits the keyboarding of several different printed output formats simultaneously with card-punching or card-reading. This feature eliminates the need for a subsequent keypunching effort and permits considerable flexibility in printout formats, such as producing an order form, a punched transaction card, and an activity journal listing from a single typewriter keyboard operation.

The actual file updating, creation of statistics and summary listings, and the publication of claim notices are planned as a batch processing step performed on a routine basis by the computer.

(5) Circulation Control Function: On-Line System

Figure III-7 illustrates the logic flow of the On-Line Circulation Control System. This system communicates with the computer by means of a keyboard/printer similar to an electric typewriter. The principal feature of the on-line system, compared with the present manual system, is that it permits the Loan Clerk to immediately determine the whereabouts of any requested item that is not on the shelf, and when

FIGURE III-7
Circulation Control Function:
On-Line System


PUBLICATION RETURNED
LIBRARIAN ENTERS CALL NO., OTHER NOS. RETURN DATE
COMPUTER UPDATES CIRCULATION FILE AND REPEATS INFORMATION
CIRCU-LATION FILE
CALL NO. OTHER NOS., DATE RETURNED
REQUEST FOR DOCUMENT
LIBRARIAN ENTERS CALL NO. ON KEYBOARD
SIGNAL SHELF RETRIEVAL
COMPUTER RETRIEVES AUTHOR, TITLE, LOCATION AND DUE DATE AND TRANSMITS TO CIRCULATION PAINTER
CIRCU-LATION FILE
IN FILE ?
NO
YES
CALL NUMBER TITLE, AUTHOR, LOCATION DUE DATE RESERVE STATUS
LIBRARIAN ADVISES REQUESTOR WHEN DOCUMENT CAN BE EXPECTED OR INITIATES INTER-LIBRARY LOAN
NEED FOR RESERVE ?
NO
END
YES
TRANSMIT RESERVE NOTE TO COMPUTER
FLAG DOCUMENT FILE RECORD WITH RESERVE NOTE
CIRCU-LATION FILE
CHECK SHELF
ON SHELF
NO
MANUAL NUMBERS CHECK
YES
RETRIEVE FROM SHELF
REQUEST FOR RENEWAL
LIBRARIAN ENTERS CALL NO., OTHER NOS. BORROWER ID, DATE DUE
COMPUTER UPDATES CIRCULATION FILE AND REPEATS INFORMATION TO LIBRARIAN
CIRCU-LATION FILE
CALL NO. OTHER NUMBERS, BORROWER ID, DATE DUE
LIBRARIAN PUTS VERIFICATION IN PUBLICATION
LOAN

its return may be expected. This feature will preclude all NOS notices and resulting searches except in the case of actual misplacement. The system operates in the following manner:

- When the Circulation Librarian receives a request from a borrower, he enters the requested item's call number (or title or author) on a keyboard/printer.
- Using the call number, the computer searches for the Master File record of the requested item and transmits the item's current location to a keyboard/printer. This location is kept up-to-date by earlier inputs which occur whenever the item leaves the shelf for a borrower, the bindery, microfilming, etc.
- The Librarian also signals the appropriate stack boy by transmitting the item's catalog number to him via a special alpha-numeric indicator panel.
- In response to the computer, a keyboard/printer prints out the requested item's title (for verification), its current location, and its due date. If the item is not available, the Librarian can add a reserve notice to the master record via a keyboard. If it is available from the shelf, the Librarian checks the item out to the borrower and reports the borrower's identification and due date to the master file via a keyboard.
- When the borrowed publication is returned, the Circulation Librarian updates the master file by entering the call number and return date on a keyboard/printer.

All special listings, such as the publication of overdue notices, serials being loaned, etc., and statistics cumulation will be performed during routine batch process operations at convenient times.

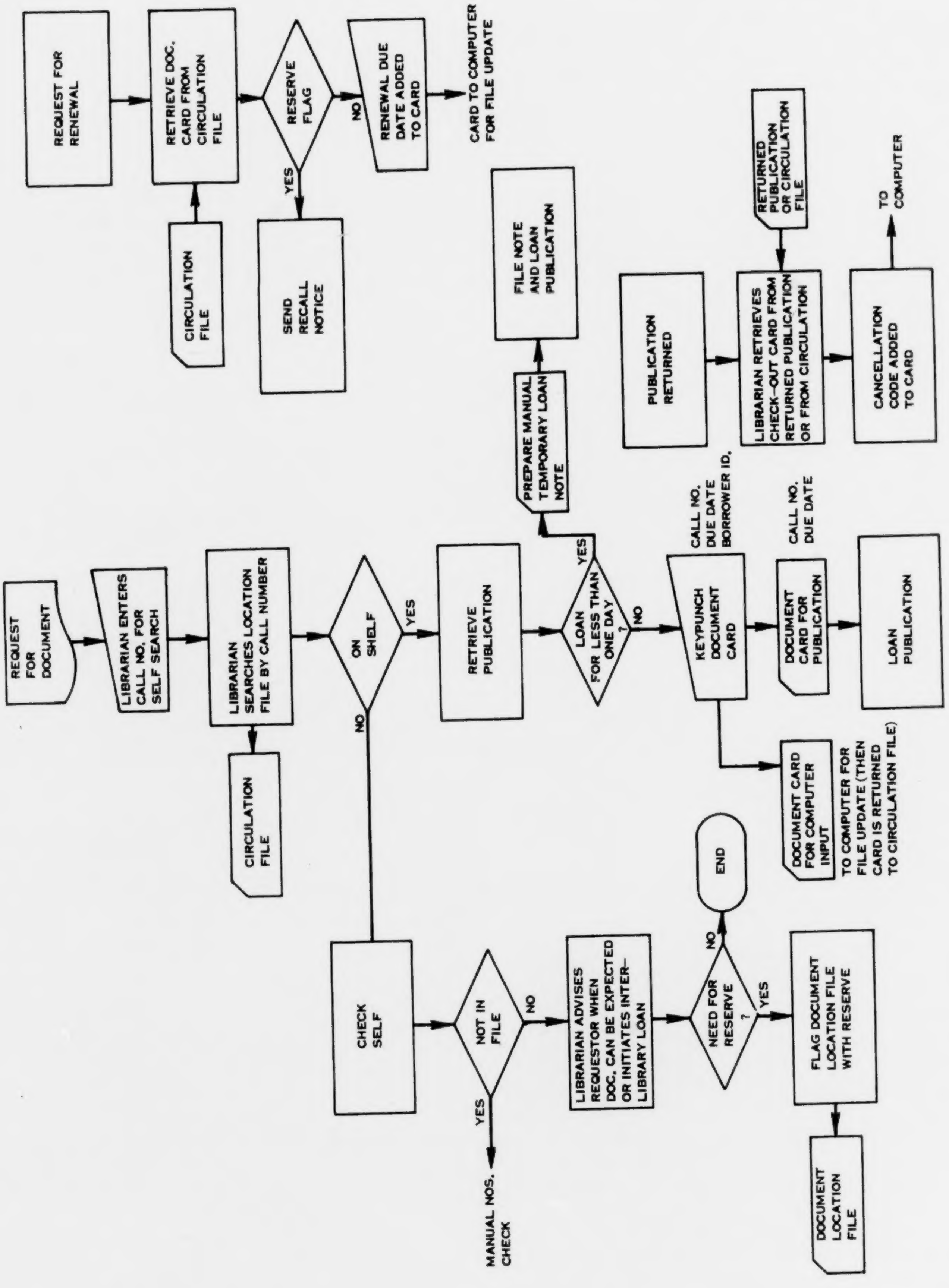
(6) Circulation Control Function: Batch Process System

The Circulation Control System is described in Figure III-8. The principal benefit of this system is in the production of the several types of notices and listings, and in the semi-automatic maintenance of the files. The system is designed to permit, as does the on-line system, the determination of the location of every publication. All movement from the shelf is reflected in the Circulation File including those to the Bindery, book maintenance, microfilming, borrowers, etc. Loans of less than one day (e.g., to a Reading Room table) are recorded manually; longer term loans are recorded on a punched card.

This version of the Circulation Control Function operates as follows:

- After receiving a loan request, the Circulation Librarian searches the Circulation File and notifies the appropriate Stack Boy to retrieve the requested publication.
- If the item is on the shelf, the Librarian prepares a punched card with call number, borrower's identification, and date due. This card is duplicated; one card for the borrower is attached to the publication, the other is held for later conveying to the computer. Then the publication is loaned.

FIGURE III-8
Circulation Control Function:
Batch Process System


REQUEST FOR RENEWAL
RETRIEVE DOC. CARD FROM CIRCULATION FILE
CIRCULATION FILE
RESERVE FLAG
YES
NO
SEND RECALL NOTICE
RENEWAL DUE DATE ADDED TO CARD
CARD TO COMPUTER FOR FILE UPDATE
REQUEST FOR DOCUMENT
LIBRARIAN ENTERS CALL NO. FOR SELF SEARCH
LIBRARIAN SEARCHES LOCATION FILE BY CALL NUMBER
CIRCULATION FILE
ON SHELF
YES
NO
RETRIEVE PUBLICATION
LOAN FOR LESS THAN ONE DAY ?
YES
NO
PREPARE MANUAL TEMPORARY LOAN NOTE
FILE NOTE AND LOAN PUBLICATION
CALL NO. DUE DATE BORROWER ID.
KEYPUNCH DOCUMENT CARD
CALL NO. DUE DATE
DOCUMENT CARD FOR PUBLICATION
LOAN PUBLICATION
DOCUMENT CARD FOR COMPUTER INPUT
TO COMPUTER FOR FILE UPDATE (THEN CARD IS RETURNED TO CIRCULATION FILE)
PUBLICATION RETURNED
RETURNED PUBLICATION OR CIRCULATION FILE
LIBRARIAN RETRIEVES CHECK-OUT CARD FROM RETURNED PUBLICATION OR FROM CIRCULATION
CANCELLATION CODE ADDED TO CARD
TO COMPUTER
CHECK SELF
NOT IN FILE
YES
NO
MANUAL NOS. CHECK
LIBRARIAN ADVISES REQUESTOR WHEN DOC. CAN BE EXPECTED OR INITIATES INTER-LIBRARY LOAN
NEED FOR RESERVE ?
NO
YES
END
FLAG DOCUMENT LOCATION FILE WITH RESERVE
DOCUMENT LOCATION FILE

- If the publication is not on the shelf, and assuming it is not lost, the Librarian locates a record for it in the Circulation File. The borrower is then advised when he may expect it. If a reserve is desired, the record is flagged and returned to the file.

- When a borrowed item is returned with its check-out punched card, the card is marked with a cancellation code. The publication is returned to the shelf and its card sent to the computer.

- When a borrower desires to renew a loan, the Librarian retrieves the loaned publication's record from the Circulation File. If the record is flagged for reserve, a recall form is sent to the borrower. If not, the renewal date is added to the card and the card transmitted to the computer. A verification form is sent to the borrower.

- Loans of less than one day are handled manually by preparing a note and inserting it in the Circulation File. This will accommodate Reading Room borrowers, priority microfilming, etc.

Listings of loans by borrower, etc., recall notices, and creation of statistics will be prepared periodically by the computer.

(7) Retrieval Function: On-Line System

The two most significant features of the On-Line Retrieval System are the computer-supported thesaurus manipulation capability and the dialogue with the search strategy that is possible during actual conduct of the search. The former permits facile browsing through the thesaurus following associated word trails until the best search terms are selected. Dialogue permits the interrupting of a search in progress to refine or change the direction of the search strategy as indicated by preliminary search results.

The system logic flow is illustrated in Figure III-9. Since there is no equivalent function performed in the present NAL (except in a limited sense by the Division of Reference) no comparison of operations is possible. The following paragraphs describe the system's operation:

- Requests for information are received by the Reference Librarian (User) and identified as being either of a general or a specific nature.
- Initial descriptive terms are selected -- detailed descriptors if the request is specific and subject heading if it is general.
- The terms are entered into the thesaurus file via a keyboard/display unit. The broader term, narrower term, related terms, see's, and used for terms are displayed for the perusal of the user. Satisfactory terms are selected and stored temporarily in the display unit.
- A structured query is sent to the computer for an initial search. The computer first determines the number of retrieval items or "hits" that the query produces, and transmits this number back to the display unit.

FIGURE III-9
Retrieval Function:
On-Line System

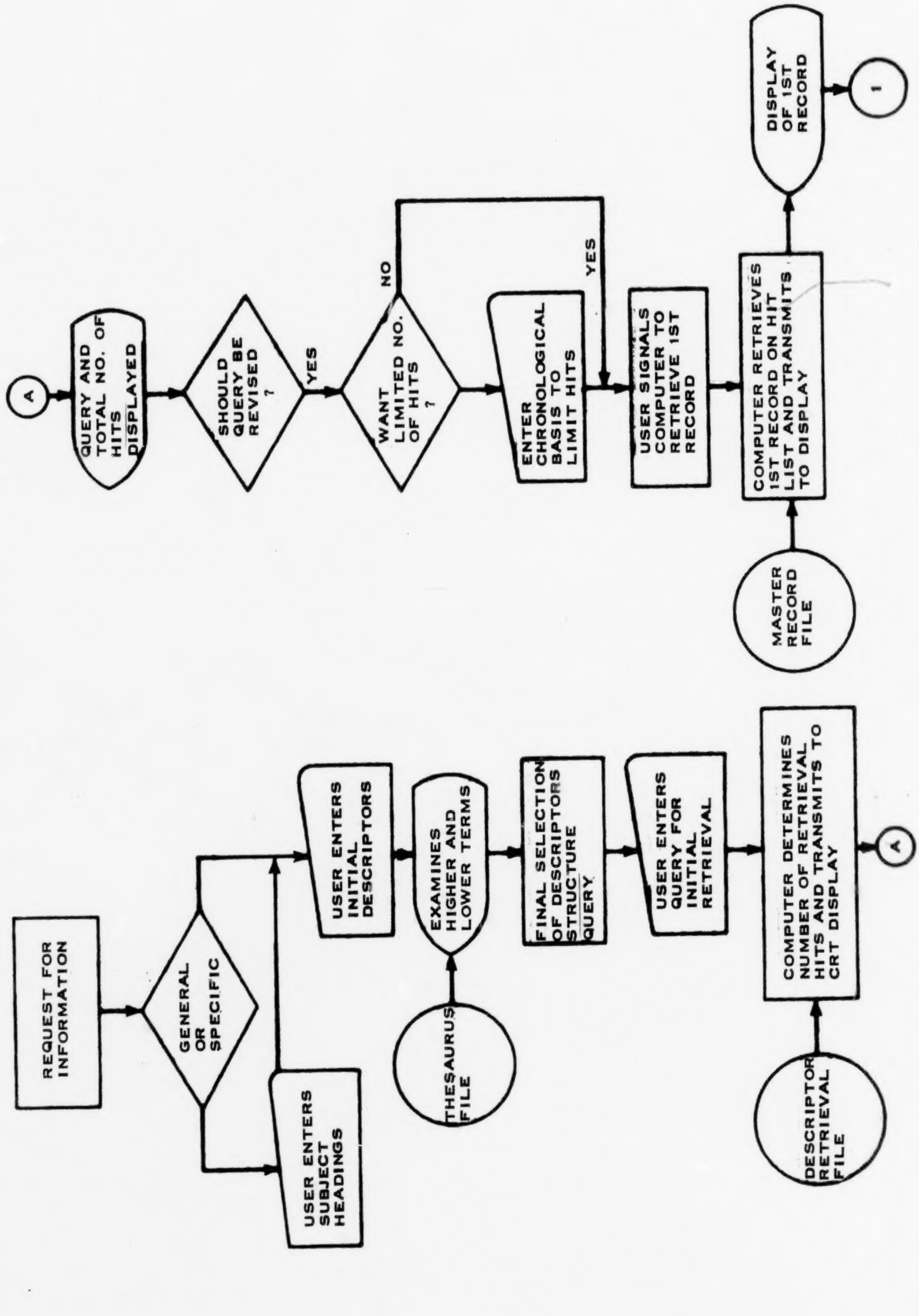
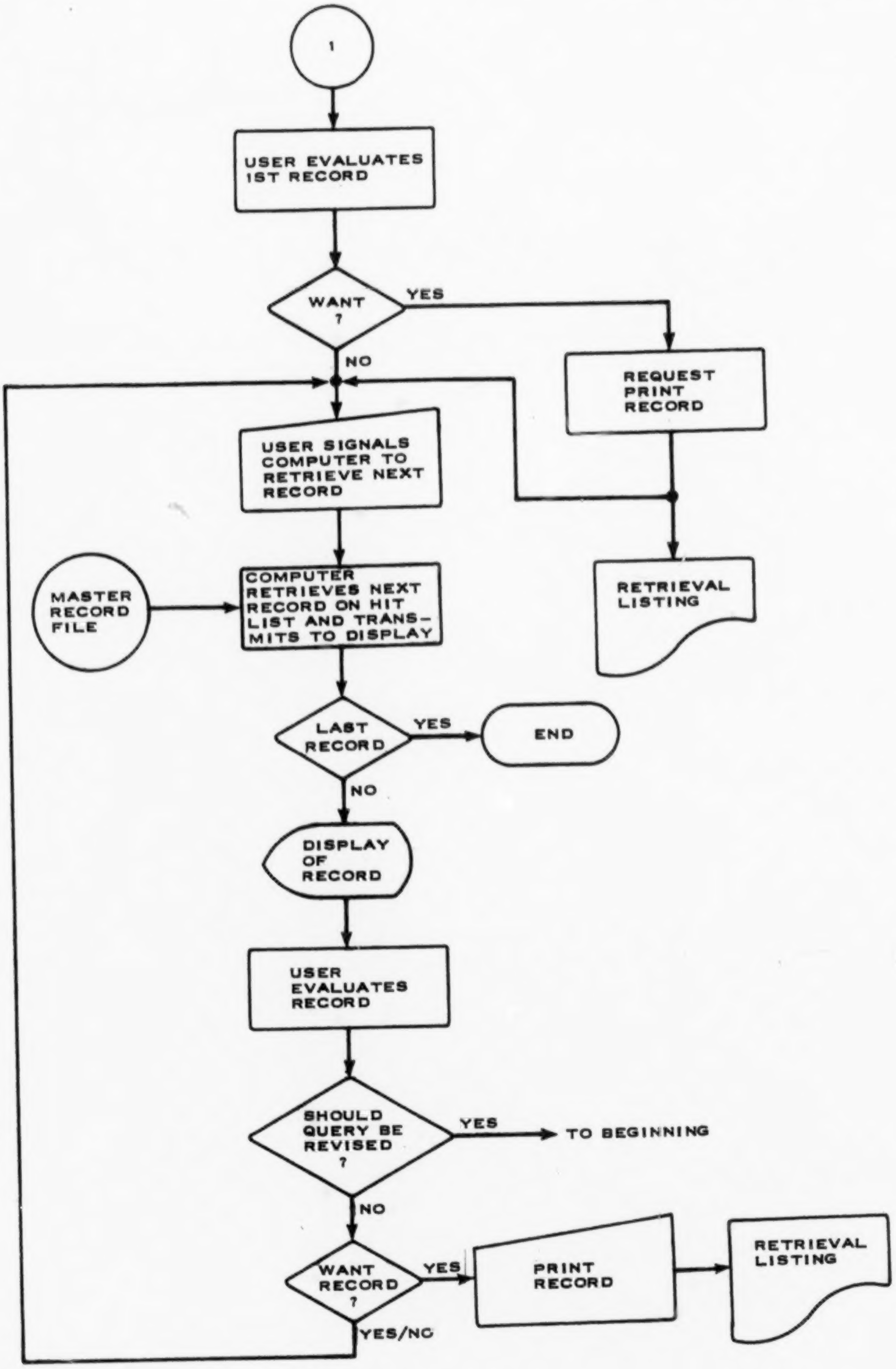

REQUEST FOR INFORMATION
GENERAL OR SPECIFIC
USER ENTERS SUBJECT HEADINGS
USER ENTERS INITIAL DESCRIPTORS
EXAMINES HIGHER AND LOWER TERMS
THESAURUS FILE
FINAL SELECTION OF DESCRIPTORS STRUCTURE QUERY
USER ENTERS QUERY FOR INITIAL RETRIEVAL
COMPUTER DETERMINES NUMBER OF RETRIEVAL HITS AND TRANSMITS TO CRT DISPLAY
DESCRIPTOR RETRIEVAL FILE
A
A
QUERY AND TOTAL NO. OF HITS DISPLAYED
SHOULD QUERY BE REVISED ?
YES
WANT LIMITED NO. OF HITS ?
NO
ENTER CHRONOLOGICAL BASIS TO LIMIT HITS
YES
USER SIGNALS COMPUTER TO RETRIEVE 1ST RECORD
COMPUTER RETRIEVES 1ST RECORD ON HIT LIST AND TRANSMITS TO DISPLAY
MASTER RECORD FILE
DISPLAY OF 1ST RECORD
1

FIGURE III-9a
Retrieval Function:
On-Line System (cont.)


1
USER EVALUATES 1ST RECORD
WANT ?
YES
NO
REQUEST PRINT RECORD
USER SIGNALS COMPUTER TO RETRIEVE NEXT RECORD
MASTER RECORD FILE
COMPUTER RETRIEVES NEXT RECORD ON HIT LIST AND TRANSMITS TO DISPLAY
RETRIEVAL LISTING
LAST RECORD
YES
END
NO
DISPLAY OF RECORD
USER EVALUATES RECORD
SHOULD QUERY BE REVISED ?
YES
TO BEGINNING
NO
WANT RECORD ?
YES
PRINT RECORD
RETRIEVAL LISTING
YES/NO

- At this point the user may either change his query or limit the items retrieved on some arbitrary basis such as chronological. If he chooses to revise, he cancels his initial query and enters the revised one. To simply limit the number retrieved, he enters a directive such as "last 40" or "first 10."

- The selected retrieved records are then displayed one at a time for further perusal. This record would be limited to title, author, date, publication, and indexing terms.

- The user reviews the abbreviated records as they appear and identifies those which he desires to be printed. As the retrieval progresses, the user may again decide that the query should be revised to improve the retrieval results. If this is the case, he may interrupt the retrieval, reformat the query, and begin again. The retrieval is terminated when the last desired record has been printed. The user may decide that his retrieved items are too many to warrant the delay due to mechanical printing. He may then request a printout of only accession numbers, or he may request the computer to prepare his full printout as a batch process operation at a later time and have the printout mailed or delivered to him.

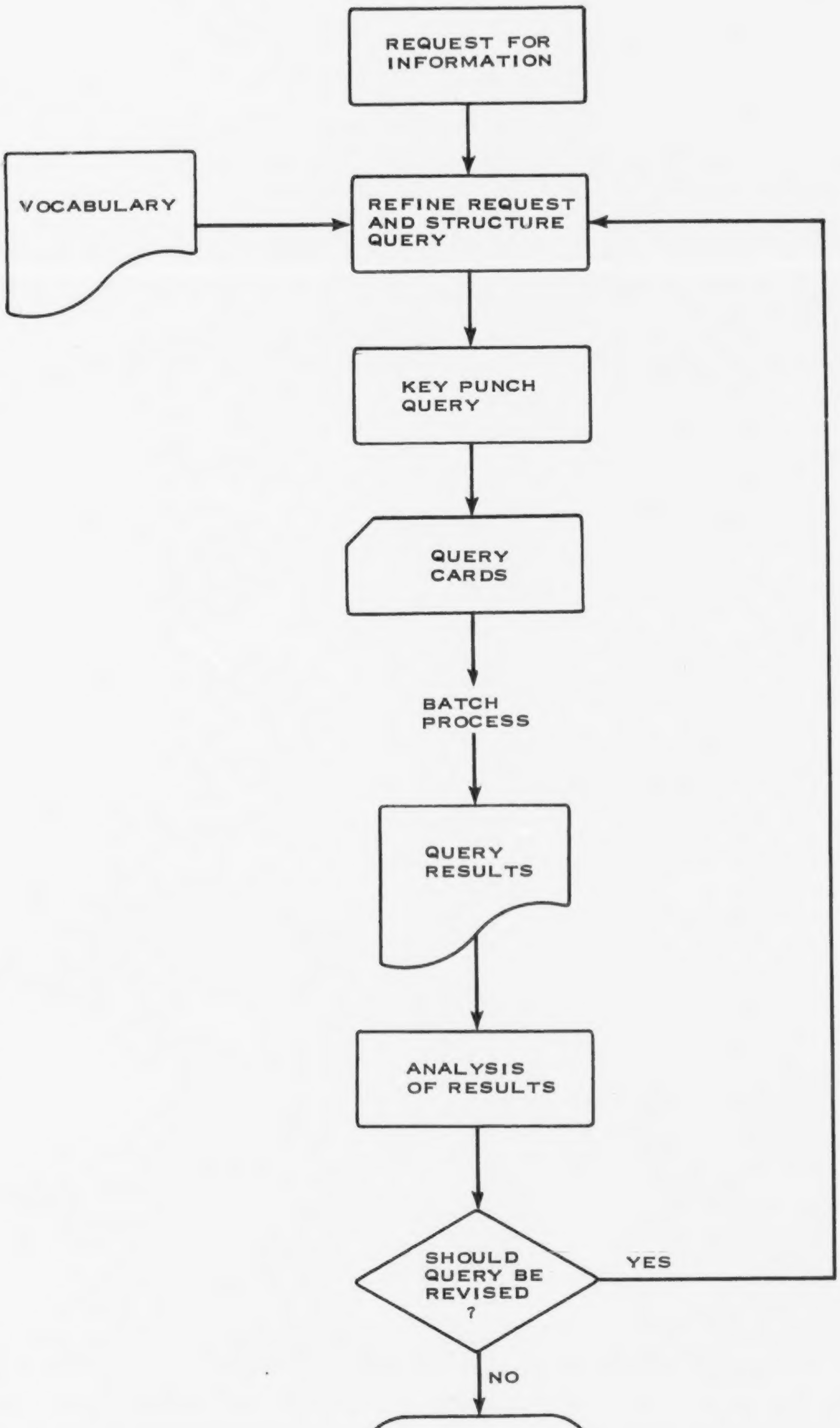
The batch process operations associated with the Retrieval Function would include items such as special bibliographies, special information outputs (e. g., PIC Bulletins), general bibliographies (e. g., Bibliography of Agriculture), and special current awareness outputs (e. g., Selective Dissemination of Information). The outputs to be printed for distribution would be given an additional editing step by step, provided with upper/ lower case characters, diacritical marks, etc., and formatted for automatic printing on the Government Printing Office's new Linotron machine. The design details for producing these outputs and the method by which upper/lower case and special characters are to be handled will be determined in the second phase of the project.

(8) Retrieval Function: Batch Process System

Figure III-10 illustrates the logic flow of the batch process approach to performing the retrieval function. This system is much simpler than the on-line system since the user is involved only at the input and output. No user-interruption of the retrieval process is possible and revision of the query cannot be finished until the process is complete. Query terms are made from a printed subset of the Vocabulary. The system operates in the following manner:

- The Reference Librarian structures a request for information into a system query using terms selected from the Working Vocabulary. This Vocabulary printout will list each working term alphabetically along with its broader term, narrower term, related terms, see's, and used for terms.
- Selected terms, structured with Boolean operators, are keypunched and conveyed to the computer (or transcribed and conveyed to the computer where keypunching occurs.

FIGURE III-10
Retrieval Function:
Batch Process System


REQUEST FOR INFORMATION
VOCABULARY
REFINE REQUEST AND STRUCTURE QUERY
KEY PUNCH QUERY
QUERY CARDS
BATCH PROCESS
QUERY RESULTS
ANALYSIS OF RESULTS
SHOULD QUERY BE REVISED ?
YES
NO
END

- The computer retrieves and prints out those items that "hit" on the query. The printout will consist of full bibliographic information unless the hits exceed a predetermined limit. In this case the user will receive an abbreviated printout of the limited hits plus the number of total hits. The user receives the retrieved results and has an opportunity to revise his query. The revision is submitted as an entirely new query and the process is repeated.

The outputs described in the on-line system as batch process outputs will also be produced in this system.

(9) Subject Analysis Function: On-Line System

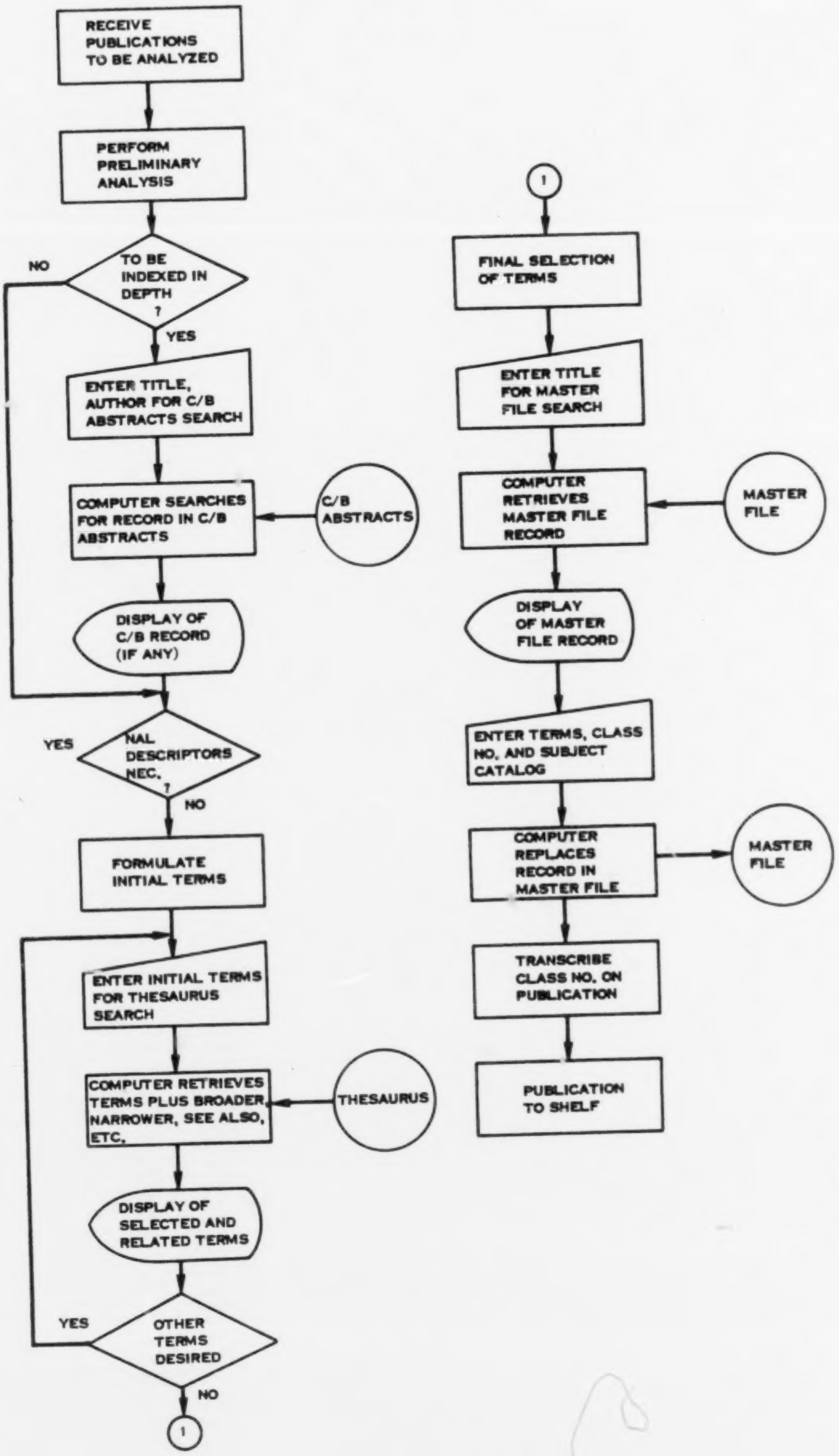
The two primary advantages to performing the subject analysis function on-line are:

- Machine assistance in the selection of subject terms from the vocabulary (thesaurus)
- Access to the machine-readable file from other systems such as the LC-MARC tape, the NLM-MEDLARS tape, and the Chemical-Biological Abstract tape.

Figure III-11 illustrates the operation of the on-line system. The following paragraphs describe this operation:

- The analyst receives a publication and determines whether to perform an in-depth indexing or a general subject cataloging.

FIGURE III-11
Subject Analysis Function:
On-Line System


RECEIVE PUBLICATIONS TO BE ANALYZED
PERFORM PRELIMINARY ANALYSIS
TO BE INDEXED IN DEPTH ?
NO
YES
ENTER TITLE, AUTHOR FOR C/B ABSTRACTS SEARCH
COMPUTER SEARCHES FOR RECORD IN C/B ABSTRACTS
C/B ABSTRACTS
DISPLAY OF C/B RECORD (IF ANY)
NAL DESCRIPTORS NEC. ?
YES
NO
FORMULATE INITIAL TERMS
ENTER INITIAL TERMS FOR THESAURUS SEARCH
COMPUTER RETRIEVES TERMS PLUS BROADER, NARROWER, SEE ALSO, ETC.
THESAURUS
DISPLAY OF SELECTED AND RELATED TERMS
OTHER TERMS DESIRED
YES
NO
1
1
FINAL SELECTION OF TERMS
ENTER TITLE FOR MASTER FILE SEARCH
COMPUTER RETRIEVES MASTER FILE RECORD
MASTER FILE
DISPLAY OF MASTER FILE RECORD
ENTER TERMS, CLASS NO, AND SUBJECT CATALOG
COMPUTER REPLACES RECORD IN MASTER FILE
MASTER FILE
TRANSCRIBE CLASS NO. ON PUBLICATION
PUBLICATION TO SHELF

- If appropriate, a keyboard entry is made to search the Chem-Bio Abstract file. If a record exists for the publication, it will be displayed on the keyboard/display console. The same search is performed in the MEDLARS file and the MARC file. Candidate terms are selected.

- The analyst next transmits the title to the computer for a search of the vocabulary for equal or synonymous terms. A display of these terms with their "broader," "narrower," etc. relationships is made and candidate terms are selected. All of the candidate terms are pursued by the analyst in the vocabulary hierarchy by cursory selection on the display or by keyboard entry until the final term list has been determined.

- The final terms are then posted to the Master File record of the publication, and if necessary, a call number is assigned. The publication is then given whatever accessories are needed, such as a spine label and other markings and it is transmitted to the shelf.

Production of a catalog and preparation of the initial format for the Bibliography of Agriculture would be performed by batch processing.

(10) Subject Analysis Function: Batch Process System

The performance of the subject analysis function in a purely batch process system would be entirely manual. Indexing and subject cataloging tools would consist of the computer printed NAL catalog and a working vocabulary. Also, the computer printed catalog of LC, NLM, and Chem Bio-Abstracts would be used. The selection of subject terms and call numbers would be transcribed on a worksheet along with identifying bibliographic information, and subsequently these worksheets would be keypunched. Updating of the Master File record, production of catalog cards, and preparation of an initial machine-readable format for printing of the Bibliography of Agriculture would be done periodically by the computer.

IV. SYSTEMS EVALUATION: A COMPARATIVE ANALYSIS

IV. SYSTEMS EVALUATION: A COMPARATIVE ANALYSIS

This section discusses the comparisons between the current manual operation and the proposed ADP systems approaches. The basic systems alternatives are evaluated by means of a detailed analysis of their ability to satisfy the design criteria and ranked according to Criteria of Evaluation (COE).

Attempting to define, in general terms, comparative analysis poses somewhat of a semantics problem. Numerous terms are in current use which tend to convey the same general meaning, but which apparently have different meaning to different people: cost-benefit analysis, cost-effectiveness analysis, system analysis, utility analysis, etc. Because of such terminological confusion, all of these general concepts have been combined in this report into the term "comparative analysis."

The comparative analysis presented in this report has the following major characteristics:

- A systematic examination and comparison of the proposed alternative approaches which can be used to achieve the NAL automation objectives for the 10-year time period.

- Assessment of cost (in the sense of economic resource cost)
- Assessment of utility (the benefit or gains)
- Quantitative factors are supplemented by qualitative analysis. An appropriate combination of quantitative and qualitative factors is stressed.

The comparative analysis is based on the Fixed Utility concept in which the design criteria is considered as minimum requirements which must be satisfied by each alternative. In order to assume the fixed utility approach it is first necessary to arrive at a set of design criteria which would allow alternatives to be designed against a single, explicit standard. These standards and their definition are presented in Section III.

To evaluate the utility of the designed alternatives and the current operation it was then necessary to develop a Criteria of Evaluation (COE) which allow alternative proposals to be compared. A listing of the COE is presented below:

* 1. Responsiveness to user

2. Ease of organizational implementation

---

* Indicates priority criteria.

* 3. Personnel utilization

* 4. Master planning appropriate to NAL needs

5. National assistance

* 6. Control and surveillance

* 7. Implementation

* 8. Cost implications

This list satisfies the following questions concerning the NAL environment:

- Will the COE assure that the alternatives are considered in the unique context of the NAL?
- Will the COE assure that the alternatives are to be judged in terms of the design criteria?
- Do the COE include a logically complete analysis of the data processing job to be done?
- Are the relevant aspects of economy, efficiency, and effectiveness addressed? (Is due regard given to means and resources available?)
- Are all of the known significant problems covered by the COE?

Completeness is not the only desirable feature of the list of criteria. If it is to become a reasonably credible instrument for measurement, or at least for comparison, the relative emphasis and definitation to be given to each criterion has to be indicated and justified. Priority is given to the six criteria (1, 3, 4, 6, 7 and 8) indicated by asterisks. The following discussion defines each COE and relates it directly to the NAL environment:

* 1. Responsiveness to user includes both the completeness and timeliness of the services available to the users of the NAL. As such, it is a measure of the commitment to automation and effectiveness of the system design. Responsiveness results in the ability for the users to achieve and maintain the high information standards considered vital to the research community. The user and in turn the system's ability to be responsive is considered to be the fundamental factor in the design and implementation of an automated system.

2. Ease of organizational implementation indicates the degree of resistance an alternative can be expected to encounter organizationally, and how many specific organizational changes are implied by that alternative. Thus, this criterion measures one "cost" associated with implementing a mechanized concept, but says nothing about benefits. The organizational impact of implementation must be evaluated for each alternative, but it is one of the less heavily weighted factors among the list of criteria.

* 3. Personnel utilization reflects on the ability to achieve maximum effectiveness from the personnel involved in the system. It measures the system's ability to utilize specific skills with a minimum of distraction and the ability to supplement the intellectual processes with tools for minimizing routine or clerical operations. Since qualified ADP and Library personnel are in such high demand and available in insufficient numbers, this criterion is extremely important.

* 4. Master planning is the design function which enables individual alternatives to be integrated into the non-ADP aspects of current and future NAL operations. It relates to the capability to establish long-range ADP objectives, define the steps necessary to achieve these objectives, and issue addendum as either the

objectives or intermediate steps require alteration. This step is absolutely essential if mechanized alternatives are to be responsive to the fundamental requirement of the NAL mission and the National Network.

5. National assistance relates to the system's ability to respond to the needs of other libraries. NAL should assume the role of leadership in the national network of agriculturally-oriented libraries. In addition to providing user services to these libraries, NAL can give advice and guidance in planning, organization, and operation of automated library functions. The system must have the capacity to respond to these requirements when they arise. The system's ability to implement and control a national or regional library network must be measured.

* 6. Control and surveillance relates to the ability of the system to organize and control its operation, survey and assess its services, and to initiate new or modified projects. This criterion measures the system capacity to evaluate results versus plans and initiate corrective action where deficiencies occur. The impact of this self-evaluation criterion makes it one of the more important evaluation factors.

* 7. Implementation is the process by which a proposed alternative becomes an operational system. Implementation is a direct function of the complexity of the system and procedures, and depends on the ability to evolve, through careful master planning, from one intermediate step to another. The ability to implement the system design concepts is the most essential factor in the system design evaluation process.

* 8. Cost implications are of interest as a partial measure of quantitative value in the absence of any other quantitative analysis. While these data are enlightening, they represent only part of the total story as related to the comparative analysis and, therefore, should be viewed only as an aid in sharpening the decision-maker's intuition and judgment.

These criteria are considered well-suited to their specific purpose, which is to reveal more clearly the consequences of choosing one or another of the mechanization schemes which appear feasible.

To evaluate the effectiveness of the existing methods as well as the proposed approaches, their adequacy in meeting the eight criteria will be reviewed. Such an analysis is structured so that each proposed alternative is evaluated in the same manner for comparison with one another and with the existing system. In so doing, there has been no attempt to assess the efficiency of utility of system performance as could be expected today. Emphasis has been placed on an evaluation of the potential of each alternative.

Evaluation of Proposed Alternatives

This section evaluates in narrative chart form, Table IV-1, the adequacy of the present, batch, and on-line systems in meeting each of the eight criterion. A second comparison, Table IV-2, is made by rating their adequacy against a standard of "excellent," "good," "fair," or "poor." The overall effectiveness is a profile of eight such judgments. An ideal approach which exceeds the requirements would be judged "excellent" for all criteria. A rating of "good" indicates compliance to the requirements. A judgment of "fair" performance may be acceptable, but would be difficult or expensive to improve. A judgment of "poor" performance should be considered only if there is a reduction in the stated design criteria.

An evaluation of this type is subjective and, therefore, debatable. These judgment values are based on the following factors:

- Our observation of the present NAL environment
- Our knowledge of the trends in the development of library automation systems
- Our awareness of the factors influencing ADP in USDA
- Our knowledge of the future responsibilities of NAL to the agricultural research community
- Our evaluation of the national role of NAL.

CRITERIA OF EVALUATION	PRESENT SYSTEM	BAT
*1. Responsiveness to Users	The individual and institutional users are not provided with 50% of the services and 90% of the frequency required by the design criteria. The higher order benefits considered vital to the NAL national role cannot be realized by upgrading manual techniques.	Each of the se operation are with the added as required. essential featu the user to est The system de responsivenes but the necess tions that wou of this. Certa culation, refe quirements fo Maintenance a files with a ba desired burde would lack ti procedure.
2. Ease of Organizational Implementation	This is not applicable, since the organization already exists.	A major new complete auth of NAL. Thi sibility away
*3. Personnel Utilization	Each functional area within NAL using ADP must hire, train, and assign personnel within its own recognized needs. There is no mechanism based on any overall priority system for assigning personnel resources. The training is then considered unique to that functional area and relocation is difficult. The method does not allow for general flow of ADP knowledge throughout the NAL staff. ADP functions are organized and performed independently of the normal library functions.	A common po tablished with all of the libr in each functi specialists to tween their o system. Som enced by the in responses file retrieval Creative libr diluted by int
*4. Master Planning	There is no master planning for data processing in NAL, though some planning is being performed in individual functional areas. There is no organizational entity that can perform effective ADP master planning for NAL as a whole. ADP projects, therefore, cannot be defined in terms of a master plan where no master plan exists. The present staff often makes reasonably effective efforts to coordinate informally with personnel representing other areas with emphasis on the national network.	NAL would b internal mast be constraine resources. to other natio ies at the im strained. Th natives' inabi the-art in co

TABLE IV-1

Comparative Analysis

BATCH PROCESSING SYSTEM	ON LINE PROCESSING SYSTEM
Each of the services considered vital to NAL operation are represented in this alternative, with the added capability to provide new services as required. However, this alternative lacks the essential feature of timeliness and the ability of the user to establish a dialogue with the system. The system design might provide a satisfactory responsiveness, on an individual "rush" basis, but the necessary manual and scheduling operations that would be required provide no guarantee of this. Certain Library functions (e.g., circulation, reference, serial check-in) have requirements for real time access to files. Maintenance and up-dating of manual look-up files with a batch process system place an undesired burden on the Library personnel and would lack timeliness under any practical procedure.	The responsiveness to the user has unlimited potential in the on-line system since the user is indeed a part of the system. It is the user through his direct access console who assists in the development of the system, its software, and its files.
A major new organization must be created with complete authority to schedule ADP activities of NAL. This, of necessity, would take responsibility away from the existing functional areas.	A major new organization must be created, but the scheduling of the ADP activities would remain "on-line" within the functional areas.
A common pool of ADP specialists can be established within NAL to apply their talents to all of the library functions. The professionals in each function can work jointly with these specialists to create effective interfaces between their operations and the processing system. Some inefficiencies will be experienced by the library personnel by both delays in responses due to scheduling and by manual file retrieval for real time requirements. Creative library activity will continue to be diluted by intermingled clerical type operations.	Optimal utilization of all ADP experts within the NAL ought to be possible with the on-line system. Training in the operation and application of remote consoles will be required for effective use by the Library personnel. Maximum effectiveness of the Library personnel is capable with an on-line system, since the system is performing the routine functions of file retrieval, creation, and maintenance, thereby allowing full attention to the creative aspects of the operations.
NAL would be in a better position to develop internal master plans, but the objectives would be constrained by the narrow orientation of the resources. Consideration of direct interfaces to other national organizations or other libraries at the implementer level would also be constrained. This is primarily due to this alternatives' inability to match the current state-of-the-art in computer technology.	NAL could develop master plans covering its own functional areas and coordinate to some degree with the national systems. This is possible because of the added flexibility of the on-line alternative with its inherent ability to modify itself.

CRITERIA OF EVALUATION	PRESENT SYSTEM	
5. National Assistance	NAL does not have the resources to render sufficient and authoritative assistance to field libraries or other such institutional users as defined by the design criteria. Isolated attempts to work with other libraries on a network basis have been academic in nature and are hampered by the lack of resources and master planning within NAL. Some assistance is currently provided through the printed services of the B of A.	With the ab this approa to function siveness s content but ability to e constraine techniques
*6. Control and Surveillance	NAL has neither the total staff nor functional experts needed to render truly a self evaluation.	The batch bility to ac to the perf mation on by the sys ing forms of the syst
*7. Implementation	Generally, individual ADP projects are executed well. The problems which sometimes beset them are usually caused by factors outside the control of the implementation group (e. g., inability to obtain software guidance for mechanization of computer oriented systems).	The prese access to mentation include a tions by i query and and backl vision and of NAL o
8. Cost Implications	The approximate annual operating budget of NAL is $2.5 millions. It is generally felt that these funds are being used effectively. The notable lack of responsiveness to the user does not detract from the accomplishments which are obtained for these expenditures. It should be recognized that the application of larger funds to the present system will not in itself provide the capability to satisfy the design criteria.	Five-year the altern vestment S (File Mem Computer User I/O Software Data Prep Computer Notes: (1) Softw 72 m (2) Data shift end c punc (3) Comp one- to si

TABLE IV-1(continued)

	BATCH PROCESSING SYSTEM	ON-LIVE PROCESSING SYSTEM
der field rs as at- net- e and and istance d ser-	With the ability to meet the design criteria, this approach provides the capability for NAL to function in a national environment. Responsiveness should be adequate with regard to content but may be deficient in timeliness. The ability to evolve into a national network will be constrained to the potential of the batching techniques and schedule.	This approach provides the capability to meet the varying requirements likely to be involved in any network organization. Interface systems can be developed such that remote libraries are truly integrated into the system. NAL can provide leadership in the state-of-the-art in library automation techniques.
tional ex- uation.	The batch processing system provides the capability to accumulate and analyze data pertaining to the performance of the system. Since information on the users activities is not registered by the system, special procedures and reporting forms are required for complete evaluation of the system performance.	All ADP personnel would be available for these functions, as necessary, and direct control of all development and implementation of self-evaluation schemes would be performed within the system. This would eliminate manual acquisition of data. The user is an integral part of the control and surveillance of the library.
exe- times rs out- group ance for stems).	The present system incorporates real time access to manually manipulated files. Implementation of a batch processing system will include a major change in some of these functions by interjecting a time delay between the query and the answer. Scheduling, priorities, and backlog control will require close supervision and conflicts must be resolved in light of NAL objectives.	Implementation of an on-line system is aided by continuing to provide real time access to the files while minimizing routine clerical functions. Quality control is a continuing function of the system since each operation is monitored. Conflicts in scheduling are not a common occurrence except for those functions which are performed by this system operating in the batch processing mode.
get of felt vely. the user nents res. It on of not in the	Five-year cumulative costs are the lowest of the alternatives presented. Estimated investment costs are: SYSTEM BUDGETARY COSTS (FIVE-YEAR CUMULATIVE) File Memory $ 750 K Computer Complex 700 K User I/O Devices 180 K Software Development 1,800 K Data Preparation 540 K Computer Operating Personnel 200 K $4,170 K Notes: (1) Software development costs are based upon 72 man-years of effort at $25 K/man-year (2) Data Preparation costs are based upon one-shift operation, gradually expanding at the end of five years to an equivalent keypunching capacity of 725 cards per hour. (3) Computer operation costs are based upon one-shift operations, gradually expanding to six men at $10 K/man-year.	The increased investment cost of the on-line systems is a direct relationship to the benefit gains. The major benefits gained are those involved with increased response time rather than service provided. The on-line system will also provide the ability to establish a dialogue with the file and flexibility of output. Estimated 5-year investment costs are: SYSTEM BUDGETARY COSTS (FIVE-YEAR CUMULATIVE) File Memory $ 955 K Computer Complex 1,350 K User I/O Devices 700 K Software Development 2,500 K Data Preparation 75 K Computer Operating Personnel 170 K $5,750 K Notes: (1) Software development costs are based on 100 man-years of effort at $25 K/man-year. (2) Computer operation costs are based upon one-shift operations, gradually expanding to six men at $10 K/man-year.

Table IV-2
Systems Rating

		PRESENT SYSTEM	BATCH PROCESSING SYSTEM	ON-LINE PROCESSING SYSTEM
*1.	Responsiveness to User	Poor	Good	Excellent
2.	Organizational Implementation	Not Applicable	Fair	Fair
*3.	Personnel Utilization	Poor	Fair	Good
*4.	Master Planning	Poor	Good	Good
5.	National Assistance	Poor	Good	Excellent
*6.	Control and Surveillance	Fair	Good	Excellent
*7.	Implementation	Good	Fair	Good
*8.	Cost Implications	Fair	Fair	Good
	5 Year Cumulative Costs (x 1000)	$2, 500**	$4, 170	$5, 750

* Critical Items
** Annual Operating Cost

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VI. GLOSSARY

VI. GLOSSARY

Access, Random

Pertaining to the process of obtaining information from or placing information in storage where the time required for access to the storage location is independent of the location most recently accessed. In practice, memory devices such as disc files are termed random access even though the access time is partly dependent on the previous location used. In this context, random access is in contrast to serial access, in which access is dependent on the position of the storage location in a set of storage locations which must be processed serially. An example of a serial access storage medium is magnetic tape.

Access Time

Time required to read or write a character or work files in a particular location. Frequently used to mean average access time for all locations in a particular storage unit.

Alphanumeric

A coding system capable of representing alphabetic characters, numerals, and other symbols.

Automatic Transaction Recorder

Systems for recording several of the facts about a transaction with minimum manual input. For example, in a job ship the recorder will pick up the worker and job identification from plates or cards and the start-stop times from a built-in clock, so that only the quantity completed is punched into the keyboard or set up in dials for recording.

Batch Processing

Collection of data over a period of time for sorting and processing as a group during a particular machine run.

Bit

A binary digit; hence, a unit of data in binary notation; abbreviated from binary digit.

Buffer

A device used to compensate for differences in speed between two devices to permit them to operate together.

Card Punch

A device for punching data onto cards. Equipment vary from hand punches to high-speed punches for magnetic-tape-to-card conversion or direct output from the processor.

Central Processing Unit (CPU)

The device containing the arithmetic unit, control unit, and main memory. Also referred to as the main frame.

Debug

To locate and correct errors in a program or malfunctions in equipment.

Disc (Disk), Magnetic

A rotating metal disc having a magnetized surface on which information may be stored. A disc file is an auxiliary device containing an array of discs and read-write heads mounted on arms which read and write on the disc surfaces.

Display

Visible representation of data on a console, in a printed report, or by other means.

Feasibility Study

Preliminary process of determining the over-all suitability of applying data processors to specific operations; involves both technical and economic considerations.

File

One or more records concerning people, things, or places that are closely related and handled together for processing.

File Analysis

A study of file characteristics to locate file redundancies or similarities and to list documents affecting a file and data elements contained in a file.

Interrupt

Stopping the normal operation of a program to perform a different operation, after which control may be resumed at the point of interruption.

Library Routine

A prewritten, standard routine for use in other programs. The term "library" refers to the nature of the routine and not to the area of application.

Off-Line Equipment

Equipment not connected directly to the central processor, but working through an intermediary device.

Program

(1) The set of instructions to solve a problem.

(2) To plan the procedures for solving a problem.

Punched Card

A card of standard size and shape in which data are stored in the form of punched holes. The hole locations are arranged in 80 or 90 columns with a given pattern of holes in a column representing one alphanumeric character. The data content is read by mechanical, electrical, or photoelectrical sensing of the hole positions.

Punched Tape

Tape, usually paper, in which data are stored in the form of punched holes arrayed in a pattern across the tape.

Random Access

See "Access, Random."

Record

Data-processing system output that has high information content; more broadly, any planned and organized output from a system.

Software

The programming aids available for a computer. These include library routines, assembly routines, utility routines, compilers, and applications programs. Contrasted to hardware.

APPENDIX A

EXPERIENCE IN AUTOMATION AT THE NATIONAL LIBRARY OF MEDICINE

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EXPERIENCE IN AUTOMATION AT THE NATIONAL LIBRARY OF MEDICINE

During the analysis phase of this contract, the study team reviewed the background and status of other library automation projects. Since there is a very limited number of operational systems, there was not an abundance of information relating to the performance of automated library systems. Fortunately, the National Library of Medicine has several years of experience in operating the Medical Literature Analysis and Retrieval System (MEDLARS). The similarity in some of the goals for an automated NAL and those of MEDLARS indicated that some knowledge of their experiences would be helpful. The remainder of this report summarizes our review of the available information concerning MEDLARS.

1. GENERAL

MEDLARS is a mechanized information retrieval system developed and operated by the National Library of Medicine to produce NLM's publication, Index Medicus. This publication is in many ways similar to the NAL's Bibliography of Agriculture; a comparison of the two is given on page 44C of the Project ABLE report.

The implementation of MEDLARS was contracted to the General Electric Company for delivery by January 31, 1964. By 1969 the MEDLARS file will contain more than one million citations. Each year more than 175,000 articles from 2,4000 U.S. and foreign medical journals are received and indexed. The principal system outputs are Index Medicus, demand bibliographies, and recurring bibliographies. Plans are to machine-produce a bi-weekly bulletin for distribution to other libraries to assist their acquisitions and cataloging functions. In addition, the publication of an annual catalog with a five year cumulation and the production of sets of catalog cards is planned.

Recurring bibliographies prepared by MEDLARS are distributed by government research agencies and national scientific organizations in special interest fields such as heart disease, cancer, arthritis, dentistry, drugs, and chemicals (e.g., Index of Rheumatology, Cerebrovascular Bibliography, and Index to Dental Literature).

Creating recurring bibliographies, however, presents a problem because of the inconsistency of indexers and non-relevancy of selected citations due to the technique of tagging citations at the indexing stage for bibliography printout.

Current MEDLARS outputs are created from magnetic tape, each reel containing about 30,000 citations. Because of the extent of their linear file and the length of time to pass through it, a number of jobs must be batched and processed simultaneously. These tapes are available to remote users (see NETWORKS paragraph) for their computer processing. At NLM the tapes are processed on a Honeywell 200. They can be also used on the IBM 7000 series and 360 series and the RCA Spectra series. With format changes they can be used on the CDC 1604 and the UNIVAC 1108. The programming language is ARGUS. The University of California at Los Angeles is reprogramming the ARGUS program to COBOL for the IBM 790 series.

A major criticism of MEDLARS has been its slow response to demand searches. MEDLARS has had to restrict the number of such searches it will accept. They claim the source of the problem is lack of manpower rather than in the computer process. Some of the response problems have been alleviated by using air mail for rush items and teletype for higher priority requests.

Loans of publications are now permitted only when a publication cannot be borrowed in the requestor's area. Plans are being made to provide rapid photocopy retrieval of requested abstracts or whole documents. A user's guide is now being prepared describing the range of MEDLARS services.

2. DEMAND SEARCHES

The principal advantage of MEDLARS' machine searches is that it accommodates complex questions which cannot be handled effectively by the use of traditional printed indeces or catalogs. However, searches with MEDLARS are too slow and expensive for rapid retrieval of a few references. Average machine time per search varies from 0.67 to 2 minutes per tape. (Random access files would significantly improve this.) Professional time needed per search is about three hours. Tests in 1964 indicated at 64% relevance. In 1966 it was about 80%. Irrelevancies are largely due to vocabulary weaknesses (MESH - Medical Subject Headings) and steps are now being taken to improve this.

Individual users of MEDLARS are not informed of its capabilities in detail since their local libraries have the responsibility to decide which questions are to be submitted. No request is handled unless the user agrees to provide an evaluation of the results.

3. MEDICAL SUBJECT HEADINGS (MESH)

The 1966 MESH included about 6,500 subject headings. It is still criticized, however, for a deficiency of descriptors in certain categories which cause some output irrelevancies and lower recall. MESH's headings are single concepts which are tailored for machine retrieval.

Because of this characteristic and the degree of specificity, compatibility of MESH with the Library of Congress' subject headings is presently not feasible. MESH would probably benefit from a more formal hierarchical structure relating general to specific patterns of terminology. Currently under consideration is the use of relationship indicators as a substitute for subheadings.

4. DECENTRALIZATION

NLM has decentralized its search operations by establishing remote search centers. Two of these are in operation at the UCLA Health Sciences Computing Facility and at the University of Colorado Medical Center. Others are established at the University of Alabama Medical Center, the University of Mechigan, and Harvard University. These centers will provide NLM with a continuing response feedback and constructive criticism. Some difficulties have been experienced at these centers in adapting MEDLARS tapes to their equipment.

5. FORMAT OF THE "INDEX MEDICUS"

The major dissatisfaction with the Index Medicus stems from the subject heading structure. Great difficulty has been experienced in tracing subjects toward higher levels of generality. Scope notes or an alternative are not available to assist the reference librarian.

Subject coverage has been considered by some to be inadequate. Inadequacy of cross-references cost much extra time for both catalogers and reference librarians. Subject headings are often used in the Index inconsistently. There is no listing with any title of the subject heading under which it is cross-filed.

In one test* where article title words and synonyms were matched with the subject headings, 4,093 of 4,770 articles were correctly indexed as a result. The conclusion was that the computer, given an Article title, MESH, and a synonym or thesaurus group of each subject heading, could determine what terms should be assigned. Eighty-six percent of these assignments would be the same as ones made by a human indexer.

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*Montgomery, C., and Swanson, Don R., "Machine-like Indexing by People," American Documentation, October 1962, pp. 359-66.

APPENDIX B

SYSTEM DESIGN CRITERIA

APPENDIX B

SYSTEM DESIGN CRITERIA

1. SERVICES OF NAL

The services to be provided by NAL to the agricultural and national library community are listed below and described in the following sections.

SERVICE	FREQUENCY
B of A	Monthly
Demand Searches	Demand
Information Services	Demand
Loans	Type of Service
Catalog	Monthly
SDI	Weekly
Administrative Info.	Weekly
Special Bibs.	As Needed

1. Bibliography of Agriculture (B of A) is a generic reference to a printed service of the NAL which indexes all important current books and periodical articles of agriculture and allied sciences received by the NAL. Each issue contains a list of the periodicals to be indexed or just received by NAL, a list of books

indexed in each month, a list of translations received by the Library, and announcements of new publications issued by the Department of Agriculture, the Food and Agriculture Organization of the U. N., and by State Agriculture Experimental Stations and Extension Services The data base used in preparing the printed matter is capable of being organized and arranged to reflect changes in emphasis of content and format.

2. Demand Searches is that service which results from a request for identification of information sources. The main elements of a search are generally subject and/or author. The search can be limited by language, date, specificity of subject, serial or monograph, etc. The searches result in listing of the complete citation with abstracts, if desirable. The search need not be limited to the NAL collection but may include other files, such as, Chemical Abstracts, Biological Abstracts, MARC, Index Medicus, etc.

3. Information Services involve the ability to answer specific questions rather than retrieve a document. One major step toward the development of this capacity is the Current Research Information Service (CRIS). Another service in development is the Pesticides Information Center (PIC). The information service

aspect of the Library is the most far reaching concept included in the Design Criteria. The time required to implement such a program is estimated to be 10 years.

4. Loans summarizes all of the functions required to place a requested document in the hands of the user. This service requires consideration of:

- Nature of request
- Urgency of request
- Verification of information describing the document
- Location of document
- Retrieval of document
- Inter-library loans
- Recall notices
- Reserve notices
- Delivery of document.

5. Catalog is considered the primary source of information concerning author, title, and subject for all books and journals in the NAL collection. The form (card, book, magnetic tape, computer memory, etc.) is a function of the requirements and resources of the user. Issuing a catalog and keeping it current

allows users throughout the world to determine, without delay, the published information available in the NAL.

6. Selective Dissemination of Information (SDI) is the ability to discriminately inform users of new acquisitions in their specific areas of interest. Specific new arrivals of potential interest to the user will be identified by a previously established user interest profile. The user is then advised of those items that are relevant to his indicated areas of interest. SDI profiles for groups of individual researchers or users should be considered as an effective method of implementing this service.

7. Administrative Information involves the collection of statistical data about the library for the purpose of improving the library's operations and services. Typical areas of pertinent data are:

- Budget — salaries and supplies
- The ability to obtain statistics on interest in certain subject areas to determine if a change in emphasis is required for that specific subject
- The ability to determine heavy use materials to consider dividing the collection into such areas as working collection, reading room collection, special subject collection, or truly archival collection

- Arrangement and utilization of personnel (high concentration areas).

8. Special Bibs. would be produced by the Library to identify selected references on specific subjects of current National interest. Initiating the special bibliography may result from requests of users or from the initiative of the Library in sensing the needs of the users. These Bibliographies would be recurring if necessary and might evolve into a special information service.

2. ADP SYSTEMS DESIGN CRITERIA

The following sections describe the design criteria used as the basis for developing the alternative approaches.

(1) Acquisitions System

- Descriptive cataloging done at the time of ordering
- Order record suitable to become the master record for use throught the whole system
- Access at the place of work to all routine working files
- Transaction by transaction updating of budget file
- No card refiling or routine manual file updating

- Maximum of one day delay between citation selection and the placement of an order
- Order record immediately available for reference by other uses in the NAL system
- Single order file system accessible by order number, title, supplier, order date, approximate due date, etc.
- Automatic generation of claim notices
- Automatic compilation of statistics.

(2) Information Retrieval System

- Hierarchy and relationship tracings of subject terms by machine manipulation of the vocabulary
- Same day response to routine queries
- Less than five minute response to priority queries
- Capability to rapidly search the NAL collection file, MARC, MEDLARS, and Chem-Bio Abstracts
- Ability to interrupt and modify a search during its progress based upon iterim results
- Automatic listing of retrieval results
- Ability to discriminate between general queries and specific queries

- Ability to produce scheduled iterative searches for Selective Dissemination of Information, information center outputs, Bibliography of Agriculture, etc.

(3) Subject Analysis

- Machine process assistance in selecting initial subject terms
- Hierarchy and relationship tracings of subject terms by machine manipulation of the vocabulary
- Backlog of routine publications for analysis not to exceed one day's processing
- Capability to rapidly review machine files of MARC, MEDLARS, and Chem-Bio Abstracts for cataloging and indexing information
- Integration of subject cataloging and indexing
- Automatic generation of catalog cards and book catalogs
- Capability to produce machine-readable output format for decentralized processing
- No transcription of descriptive bibliographic data except in the case of journal articles
- Access to the public catalog at the work area.

(4) Serials Control System

- All non-routine handling to be done off-line on a non-interference basis with routine check-in
- Automatic assignment of accession numbers to checked-in issues
- Automatic updating of all system files when requested issues are received
- Automatic compilation of operational statistics
- Automatic production of claim notices and binding lists
- Check-in of each issue within 24 hours of receipt
- Automatic renewal of standing subscriptions
- No manual maintenance of working files
- Process time for a routine issue not to exceed two minutes.

(5) Circulation System

- Less than 5% Not On Shelf (NOS) notices
- Determination of location of a requested publication currently on loan and its due date within one minute of quering the files
- File access by borrower's name or organization or date due
- Automatic production of overdue notices

- Twenty-four hour turnaround for most requests
- No manual file maintenance
- Ability to record temporary movements of publication to the Reading Room or for copying.

APPENDIX C

DATA ELEMENTS AND FILE CONTENTS

DATA ELEMENTS-
Present System

Code	Description
A	Title
B	Author (Personal and Corporate Researcher (i.e., CRIS)
C	Gift, Exchange, Purchase, Order Number and Date
D	Serial Expiration Date
E	Date of Publication
F	Type of Publication (Serial, Monograph)
G	Volume, Series, or Number
H	Indication of New Title (Serial title change or, specifically, a new title added to the NAL holdings; not a duplicate purchase)
I	Annotation or Note
J	Report No. (when not treated as a series)
K	Accession Number
L	Publisher
M	Vendor Information (address, blanket order information, etc.)
N	Price
O	Receipt Date

DATA ELEMENTS (Cont.)
Present System

Code	Description
P	Cataloging Status (in process)
Q	Location (physical location--i.e., stacks, B of A)
R	Type of Acquisition (Gift, Purchase, or Exchange)
S	Special Instruction to Vendor
T	Missing Issue (Claim notice to be generated)
U	NAL Address (where in NAL the publication should be sent)
V	LC Proof (Has L.C. cataloged and sent a proof on catalog cards)
W	Language and/or country
X	Routing Instructions (to B of A, Circulation, Stacks)
Y	Claim Status (has claim notice been generated--reply received, etc.)
Z	Call Number
a	Requestor I.D.
b	General and/or specific subject headings

DATA ELEMENTS (Cont.)
Present System

Code	Description
c	Special Constraints--geographical, age, acceptable number of references
d	Expected delivery date--to aid in deciding to claim
e	Reserve Note
f	Number and type of illustrations
g	Note of Non-Receipt (why, etc.)--Information for Desiderata file
h	Binding information--to be bound, how often, etc.
i	Frequency of serials
j	Where Indexed
k	Where Abstracted
l	Complete title and holdings history of NAL Serials
m	Where Translated
n	Exchange Information
o	Number of copies
p	Date Due
q	Physical forms (film, microfiche, microfilm, microcard)
r	Translation

DATA ELEMENTS-
Future System

Code	Description
A	Title
B	Author (Personal and Corporate)
C	Research (i. e., CRIS)
D	Gift, Exchange, Purchase Order Number and Date
E	Serial Expiration Date
F	Type of Publication (Serial, Monograph)
G	Volume, Series, or Number
H	Indication of New Title (Serial title change or, specifically, a new title added to the NAL holdings; not a duplicate purchase)
I	Abstract, Annotation Note, a Table of Contents
J	Report No. (when not treated as a series)
K	Accession Number
L	Publisher
M	Vendor Information (address, blanket order information, etc.)
N	Price
O	Receipt Date

DATA ELEMENTS (Cont.)
Future System

Code	Description
P	Cataloging Status (in process)
Q	Location (physical location--i.e., stacks, B of A)
R	Type of Acquisition (Gift, Purchase, or Exchange)
S	Special Instruction to Vendor
T	Missing Issue (claim notice to be generated)
U	NAL Address (where in NAL the publication should be sent)
V	LC Proof (has LC cataloged and sent a proof on catalog cards)
W	Language and/or country
X	Routing Instruction (to B of A, Circulation, Stacks)
Y	Claim Status (has claim notice been generated--reply received, etc.)
Z	Call Number
a	Requestor I.D.
b	General and/or specific

DATA ELEMENTS (Cont.)
Future System

Code	Description
c	Special Constraints--geographical, age, acceptable number of reference
d	Expected delivery date--to aid in deciding to claim
e	Reserve Note
f	Number and type of illustrations
g	Note of Non-Receipt
h	Binding information--to be bound, how often, etc.
i	Frequency of serials
j	Where indexed
k	Where abstracted
l	Complete title and holdings history of NAL serials
m	Where translated
n	Exchange information
o	Number of copies
p	Date due
q	Physical forms (film, microfiche, microfilm, microcard)

DATA ELEMENTS (Cont.)
Future System

Code	Description
r	Note of non-receipt (why etc.)--information for desiderata file
s	Translation
t	Scholarly and popular quality factors
u	Dates (CRIS)
v	Copy service
w	Complete contract information about CRIS (location, agencies involved, etc.)
x	Citations
y	Budget information (CRIS)

File Description - Present System

FILE	SIZE	INFO. CONTENT	KEY	USED FOR	FREQUENCY
CSR & Gov. Serials	105 drawers 105,000 cards	A, B, E, G, O, Q, R, T, X, Z, h, i, p	A or B	Current Serials Check-in record	Constant
ASF	594 drawers 594,000 cards	A, B, D, E, G, H, I, Q, R, T, W, Z, h, i, l, o, p, q	A or B	Complete history record of serials	Constant
Subject Authority	95 drawers 95,000 cards	b	b	Authority	Daily
Corporate Authority	Just a new file 8 drawers 8,000 cards	B	B	Authority	Daily
Public Catalog		A, B, E, F, G, I, J, L, Q, W, Z, b, c, f, i, q, r	A, B, b	Holdings location for the Public	Constant
Shelf List	737 drawers total, New--since 1966--10 drawers 737,000 cards	A, B, E, F, G, I, J, K, L, Q, W, Z, b, c f, i, o, q, r	Z	Holdings location (in-house)	Daily

File Description - Present System (Cont.)

FILE	SIZE	INFO. CONTENT	KEY	USED FOR	FREQUENCY
Claim	Variable	A, B, C, D, E, F, G, H, L, M, N, R, T, W, Y, Z, o, q, r	A or W	Claiming of mission periodicals and Monographs	Constant
Circulation	Variable	A, B, E, Z, F, G, K, a, e, q	A, q	Who has what checked out and date due	Constant
Bee culture and Beltsville shelf	14 drawers 15, 000 cards	A, B, E, F, G, I, J, K, L, Q, W, Z, b, c f, i, o, q, r	Z	Bee and Beltsville holdings	Daily
Current Citation	15 drawers 15, 000 cards	A, B, E, F, G, L, N, R, W, c, q, r	W	Publications not yet ordered - working file information not yet complete for ordering	Daily
Desiderate	45 drawers 45, 000 cards	A, B, C, E, F, G, H, L, M, N, R, S, U, W, p, q	W	Ordered in the past but without success or maybe (for budget reasons) could not be ordered	Rarely

BAARINC

File Description - Present System (Cont.)

FILE	SIZE	INFO. CONTENT	KEY	USED FOR	FREQUENCY
Serial Gap	65 drawers 65,000 cards	A, B, E, F, G, L, T, W, Z, o	A	Made from recent inventory. Funds keep this from being used	Rarely
Master Renewal	4 drawers 4,000 cards	A, B, C, D, E, F, G, L, M, N, O, S, U, W, Z, d, i, n, o	A	Renewal of periodicals	Daily
AOF	30 drawers 30,000 cards	A, B, C, E, F, G, H, J, L, M, N, S, U, W, Z,p, q, a, d, r	B or A	AOF--Alphabetical on Order File. Monographs and Serials split. Current orders	Constant
OOF	30 drawers 30,000 cards	A, B, C, E, F, G, H, J, L, M, N, O, S, U, W, Z, p, q, a, d, r	C	Monographs and serials Current orders	Constant
Retired AOF	20 drawers 20,000 cards	A, B, C, E, F, G, H, J, L, M, N, O, S, U, W, Z, p, a, q, r	B or A	Received copies, kept three years for budget	Daily
Gift and Exchange	10 - 15 drawers 10 - 15,000 cards	A, B, C, E, F, G, H, L, O, R, U, W, Z, o p, q, r	C	Same information in Master Exchange file (except gift information)	Rarely
Master Exchange	45 drawers 45,000 cards	A, B, C, E, F, G, H, L, O, R, U, W, Z, o p, q, r	W & B	Exchange record for whole department	Daily

BAARINC

Record Description - Future System

OUTPUT	DATA ELEMENT
B of A Taxonomic Index, Cumulative	A, B, E, F, G, I, J, Q, W, Z, b, f, q, t
B of A Author Index, Cumulative	A, B, E, F, G, J, Q, Z, q, x
B of A Subject Index, Cumulative	A, B, E, F, G, J, Q, Z, b, q, x
List of Current Serial Titles	A, B, D, E, G, H, O, Q, R, T, W, X, Y, Z, b, h, i, o, q
Routing List	A, E, F, Q, X, Z, a, e, o, q
Accessions List (Monographs)	A, B, E, F, H, K, L, Q, W, Z, b, f, o, q
New Serial Titles List	A, B, E, F, H, L, Q, W, Z, i, o, q
Binding List	A, B, E, F, G, Q, T, W, Z, h, i, o
Claim List	A, B, D, E, F, G, H, L, M, N, R, S, T, W, Y, i, o, q
List of Orders vs. Vender and Price	A, B, C, E, F, G, L, M, N, R, S, W, a, o, q
Renewal Notices	A, B, D, E, F, G, L, M, N, R, S, U, W, i, o, q
List of Serial Titles vs. Where Indexed	A, B, W, i, j, k, m
Serial Histories	A, B, E, F, G, H, L, M, N, Q, R, T, W, X, Z, h, i, j, k, l, o, q
Publications Available in Exchange	A, B, E, F, W, b, i, n, o, q

Record Description - Future System (Cont.)

OUTPUT	DATA ELEMENT
Outstanding Orders List	A, B, C, E, F, G, H, J, L, M, N, R, S, W, X, a, d, f, o, q
Recall Notices	A, B, E, F, G, K, Z, a, o, p, q
Lending Overdue List by Titles, Call No., or Accession Number	A, B, E, F, G, K, Z, a, o, p, q
Items Loaned Out by Title, Call No., or Accession Number	A, B, E, F, G, K, Z, a, o, p, q
Items Loaned Out by Borrower	A, B, E, F, G, K, Z, a, o, p, q
Circulation	A, B, E, F, G, K, Z, a, e, o, p, q
Statistics	To be defined
Cataloging Statistics	To be defined
Serial Check-in Statistics	To be defined
Budget Status	To be defined
Indexing Statistics	To be defined
Reference Statistics	To be defined
Serial Title by Geographic Area	A, W

Record Description - Future System (Cont.)

OUTPUT	DATA ELEMENT
Serial Title by Language	A, W
Serial Title by Subject Category	A, b
Serial Title by Frequency	A, i
Serial Title by Publisher or Institution	A, L
Demand Search Output Without Abstract	A, B, E, F, G, W, Z, b, a, c, q
SDI Notification - Research Group's Profile	a, b, W, E, F, I, A, B, q
SDI Notification - Individual's Profile	E, F, I, W, a, b, A, B, q
Demand Abstracting Service	A, B, E, F, G, I, W, Z, a, q
Demand Translating Service	A, B, E, F, G, W, Z, s, q
Demand Copying Service	A, B, E, F, G, Z, a, q
Research in Progress (CRIS)	A, B, I, b, u, w, x, y
Titles Indexed in B of A	A, B, E, F, G, K, Z
Titles Indexed in Pesticides	A. B. E. F. G. K. Z
Lending Overdue List by Borrower	A, B, E, F, G, K, Z, a, o, p, q